

THE EVOLUTION OF THE HOLARCTIC  
LEAFHOPPER GENUS *DIPLOCOLENUS* RIBAUT,  
WITH DESCRIPTIONS AND KEYS TO  
SUBGENERA AND SPECIES  
(HOMOPTERA : CICADELLIDAE)

BY  
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*Pp.* 357-413; 139 *Text-figures*

BULLETIN OF  
THE BRITISH MUSEUM (NATURAL HISTORY)  
ENTOMOLOGY

Vol. 29 No. 7

LONDON : 1974



THE BULLETIN OF THE BRITISH MUSEUM  
(NATURAL HISTORY), *instituted in 1949, is  
issued in five series corresponding to the Departments  
of the Museum, and an Historical series.*

*Parts will appear at irregular intervals as they  
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hundred pages, and will not necessarily be completed  
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*This paper is Vol. 29 No. 7 of the Entomological  
series. The abbreviated titles of periodicals cited  
follow those of the World List of Scientific Periodicals.*

*World List abbreviation  
Bull. Br. Mus. nat. Hist. (Ent.)*

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TRUSTEES OF  
THE BRITISH MUSEUM (NATURAL HISTORY)

*Issued 1 February, 1974*

*Price £2.75*

# THE EVOLUTION OF THE HOLARCTIC LEAFHOPPER GENUS *DIPLOCOLENUS* RIBAUT, WITH DESCRIPTIONS AND KEYS TO SUBGENERA AND SPECIES (HOMOPTERA : CICADELLIDAE)

By W. J. KNIGHT

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## SYNOPSIS

A possible phylogeny of the genus *Diplocoenus* Ribaut is constructed mainly on the basis of an analysis of characters of the male genitalia. The centre of origin and dispersal of the genus are also discussed. A new classification is proposed and keys and descriptions are given to the three subgenera and 35 species included within the genus. Eleven lectotypes and one neotype are designated and five new specific synonymies and three new generic synonymies proposed. Two former subspecies are raised to the rank of species and one earlier name reinstated.

## INTRODUCTION

THE genus *Diplocoenus*, first described by Ribaut in 1946, is the second largest genus of grassland leafhoppers in the Deltocephaline tribe Jassargini. It contains 35 species and is predominantly Palearctic in distribution, with only two species occurring in the New World. It comprises forms differing widely in colour and male genitalia, which have been variously segregated in the past as distinct genera or subgenera. Oman (1949: 165) considered the Nearctic species *evansi* to be sufficiently distinct from the European species on the shape of the aedeagus to be placed in a separate genus which he called *Verdanus*. This was thought to

be only a subgenus of *Diplocolenus* by Ribaut (1952 : 281), differing from the nominate subgenus by the absence of a dorsal tooth at the apex of the subgenital plate. At the same time he further segregated the subgenus *Erdianus* on the basis of a ventrally produced atrium. Later (Ribaut, 1959 : 404), he segregated a fourth subgenus, *Sabelanus*, on the presence of two pairs of apical processes on the aedeagus instead of the normal single pair. Emeljanov (1966 : 122) rejected the subgenus *Sabelanus* as an unnatural group and subdivided the genus into six subgenera principally on the structure of the subgenital plates.

The wide range of characters in the male genitalia, the majority of which have been previously neglected in the classification of the genus, suggested the present attempt to analyse the steps followed during the evolution of the group. The value of such a study lies in the resultant ability to evaluate the significance of the subgeneric groups previously proposed and to re-arrange the species, if necessary, into more natural groups in the light of the new findings. In a wider concept, it also assists, by the determination of the ancestral characters of the group and the changes that these have undergone, in a better understanding of the evolution of the tribe as a whole.

#### ACKNOWLEDGEMENTS

I should like to express my sincere appreciation to the following persons for the loan of material from their respective collections: Dr N. M. Andersen, Universitetets Zoologiske Museum, Copenhagen; Dr G. A. Anufriev, Gorky; Dr M. Boulard, Muséum National d'Histoire Naturelle, Paris; Dr J. Dlabola, Národní Muzeum v Praze, Prague; Dr I. Dworakowska, Instytut Zoologiczny, Warsaw; Dr A. F. Emeljanov, Zoological Institute, Leningrad; Dr J. P. Kramer, United States National Museum, Washington; Dr R. Linnavuori, Raisio; Dr V. M. Logvinenko, Institute of Zoology, Kiev; Mr T. Nyholm, Naturhistoriska Riksmuseet, Stockholm; Dr E. Olofsson, Universitetets Zoologiska Institution, Lund; Dr A. Soos, Természettudományi Múzeum Állattára, Budapest; Dr J. Stehlik, Moravské Museum, Brno; Dr J. Vilbaste, Institute of Zoology and Botany, Tartu; and Dr W. Wagner, Hamburg.

I also wish to thank Dr A. Kaltenbach, Naturhistorisches Museum, Vienna, and Dr J. Stehlik for their assistance in attempting to locate the Kolenati Collection, Dr I. Dworakowska for information regarding the type-series of *Deltocephalus nasti* and Dr J. P. Kramer for information on the type-series of *Deltocephalus configuratus* and *Deltocephalus evansi*.

#### ABBREVIATIONS

The majority of the material examined is in the British Museum (Natural History), abbreviated throughout the text to BMNH. Additional material is deposited in the following institutions, referred to in the text by their respective abbreviations given below in parentheses: Universitetets Zoologiska Institution, Lund, Sweden (UZI, Lund); Naturhistoriska Riksmuseum, Stockholm, Sweden (NR, Stockholm); United States National Museum, Washington, D.C., U.S.A. (USNM, Washington); Muséum National d'Histoire Naturelle, Paris, France

(MNHN, Paris); Entomological Institute, Hokkaido University, Sapporo, Japan (EIHU, Sapporo); Zoological Institute, Academy of Sciences of the U.S.S.R., Leningrad, U.S.S.R. (ZI, Leningrad); Zoological Museum of Moscow University, Moscow, U.S.S.R. (ZM, Moscow); Institute of Zoology and Botany, Academy of Sciences of the Estonian S.S.R., Tartu, U.S.S.R. (IZB, Tartu); Dr G. A. Anufriev, Kujbyshev Street, 37-27 Gorky S-74, U.S.S.R. (GAA, Gorky); Instituto di Entomologia Agraria, Universita Degli Studi, Padua, Italy (IEA, Padua); Naturhistorisches Museum, Wiesbaden, Germany (NM, Wiesbaden); Steiermarkisches Landesmuseum Joanneum, Graz, Austria (SL, Graz); Národní Muzeum v Praze, Prague, Czechoslovakia (NM, Prague); Ribaut Collection, 18 rue Lafayette, Toulouse, France (RC, Toulouse); Institute of Zoology, Academy of Sciences of the U.S.S.R., Kiev, U.S.S.R. (IZ, Kiev); Természettudományi Múzeum Állattára, Budapest, Hungary (TM, Budapest); Instytut Zoologiczny, Polska Akademia Nauk, Warsaw, Poland (IZPAN, Warsaw); Schuler Collection, Strasbourg, France (SC, Strasbourg); Dr R. Linnavuori, Saukkokuja, Somersoja, Raisio, Finland (LC, Raisio); Dr W. Wagner, Farnstrasse 36, 2 Hamburg 63, Germany (WW, Hamburg); Moravské Museum, Brno, Czechoslovakia (MM, Brno); Universitetets Zoologiske Museum, Copenhagen, Denmark (UZM, Copenhagen).

#### PRIMITIVE AND DERIVED CHARACTERS

Before attempting to reconstruct the phylogeny of a genus it is necessary to study the different conditions or states of each character and, by comparison with related genera, to determine which is the primitive and which the derived condition in each case. In studies of this kind the character condition found to be most prevalent amongst other genera is assumed to be the primitive condition for the genus under review, whilst the condition more rarely found is assumed to be derived. Certain characters, although variable, show a range of conditions peculiar to the genus under study. In such cases it is necessary, in order to find the primitive state, to search for correlations between these characters and those referred to above. In *Diplocolenus* all components of the male genitalia show variability to a greater or lesser degree and it is these structures together with body colour which have been used in the present study.

**XTH SEGMENT** (Text-figs 7-25). In the majority of species in the genus the Xth segment is large and globular. A few species, however, such as *bohemani* and *nigrifrons*, have the Xth segment relatively small with the lateral walls parallel. Since a small Xth segment is characteristic of most genera of Jassargini whilst the enlarged condition is found in only *Jassargus*, *Quontus*, *Errastunus*, *Latalus*, *Adarrus*, *Phlebiastes*, *Mogangella*, *Mendreus* and *Mendrausus*, the first five of which appear to be synonymous, the former is suggested as the primitive condition and the enlarged form as the derived state.

**CONNECTIVE** (Text-figs 65-83). Two character states occur for this structure. In one, seen for example in *frauenfeldi* and *logvinenkoae*, the arms are closely parallel distally and fused over part of their length and in the other, seen for example in *abdominalis* and *evansi*, the arms are widely divergent distally to near

apex and then abruptly angled to the midline. The first of these conditions is again the one present in the majority of genera in the tribe and is considered to be primitive whilst the second condition, seen only in *Mongolojassus*, and to a slightly modified extent in *Chelidinus*, *Laevicephalus* and *Yanocephalus*, is derived. This also follows logically from the origin of the Jassargini connective from the typical Y-shaped condition, the subsequent divergence of the arms distally resulting in their abrupt curvature to maintain contact with the aedeagus. An early stage in this development is seen in *tianshanicus*. In *Chelidinus*, *Laevicephalus* and *Yanocephalus* the transverse portion is absent and each arm articulates independently with the aedeagus.

STYLES (Text-figs 65-83). The styles vary in the shape of the apical process from the robust, triangulate form seen in *bohemani* to the acutely elongate form found in *abdominalis*. The first of these conditions is the one present in most genera of Jassargini and is therefore considered to be the primitive state whilst the elongate form, which is rarely found within the tribe outside the present genus, is considered to be derived. The styles also vary in length relative to the connective. The short style seen in *bohemani* and *orientalis* is the prevalent condition amongst other genera of the tribe and is therefore considered to be primitive whilst the long style seen in *abdominalis* and related species is present in only 25% of the genera and is considered to be derived.

AEDEAGUS (Text-figs 84-138). The basal apodeme varies considerably in shape, being either small and narrow as in *bohemani* and *nigrifrons*, short with long laterally extending arms as in *limbatellus* or long and narrow as in *abdominalis*. The first of these three conditions is the one most commonly found amongst other genera of the tribe, whilst forms with laterally extending arms occur only in *Pantallus* and *Kazakhstanicus* and the long narrow apodeme is found only in certain species of *Araldus*, *Arocephalus*, *Commellus*, *Hebecephalus*, *Henschia*, *Orocistus* and *Sorhoanus*. The *bohemani*-like apodeme is therefore considered to be the primitive condition from which the other two are derived. This conclusion is supported by correlation with other characters. Variation also occurs in the shape of the shaft which is either slender or robust, directed dorsally at the apex or with the latter turned posteriorly and with one or two pairs of apical processes. A review of the other genera in the tribe shows that a slender, dorsally directed shaft is the most commonly occurring condition whilst forms in which the shaft is turned posteriorly at the apex occur in only *Calamotettix*, *Lemellus*, *Turrutus*, *Errastunus* and certain species of *Laevicephalus*, *Mocuellus*, *Mongolojassus*, *Palus*, *Sorhoanus*, *Rosenus*, *Jassargus* and *Adarrus*. Likewise, most genera have only one pair of apical processes or none at all, two pairs occurring in only *Chloothea*, *Mendreus* and certain species of *Sorhoanus* and *Adarrus*. An aedeagus with a slender shaft, directed dorsally at the apex and with only a single pair of apical processes is therefore considered to be the primitive condition for the genus from which the other more specialized conditions have been derived. As in the case of the basal apodeme, this conclusion is supported by correlation with other characters.

**PYGOPHORE PROCESS** (Text-figs 26–45). The pygophore varies mainly in the presence or absence of a posterior process. No conclusions can be drawn in this instance by comparison with other genera but by correlation with other characters in the genus the presence of a process is seen to be the primitive condition within the genus and its loss as the derived state.

**SUBGENITAL PLATES** (Text-figs 46–64). The presence of an indentation on the lateral margin of the plates with a dorsally situated tooth at the base of the indentation are two of the diagnostic characters of the genus. Considerable variation occurs, however, in the length of the apical portion of the plates beyond the indentation, from the long finger-like condition seen in *penthopitta* to that of *configuratus*. In the search for the primitive extreme of this character, comparison with related genera is of little value since apart from the monotypic genus *Anareia*, which is otherwise dissimilar, these characters occur in no other genus within the tribe. It is necessary therefore to look for correlations with other characters within the genus for which the primitive condition is known. From such a study it is seen that in those species possessing the more primitive characters, the subgenital plates in general have only a very small or non-existent medial lobe beyond the indentation, whilst in those species with the more specialized characters the medial lobe is much longer. It seems reasonable to assume therefore that in the primitive condition the subgenital plates were short and broadly triangular with a small dorsally situated tooth apically against the lateral margin. Subsequent prolongation of the plates was impeded laterally by the tooth, resulting in the presence of an indentation. The characters of the subgenital plates were the principal ones used by both Ribaut (1952 : 281) and Emeljanov (1966 : 122) in the delimitation of subgenera. The absence of the dorsal tooth in certain species, as claimed by both workers, is seen to be incorrect whilst reliance on the subgenital plates alone without supporting evidence from other characters is seen to be misleading.

**COLOUR** (Text-figs 1–6). The majority of species in the genus are pale green with only a few stramineous with fuscous markings. The latter type of coloration occurs in the majority of genera within the tribe and is therefore considered to be the most primitive whilst the pale green condition, present in only a few genera, is considered a derived specialization.

#### PHYLOGENY

From the foregoing considerations it can be postulated that the ancestral condition for the genus was a form stramineous in colour, with a posterior process on the pygophore, a small parallel-sided Xth segment, subgenital plates without a lateral indentation but terminating posteriorly in a small dorsally situated tooth, a connective with the arms closely parallel distally and fused over part of their length, a short style with its apical process short and robust and with a simple dorsally directed aedeagus terminating in a single pair of processes and with a short narrow basal apodeme.

The form most closely approaching these conditions is that of *bohemani* which differs only in the shape of the subgenital plates. Since its nearest relatives, *configuratus*, *frauenfeldi* and *altaicus*, however, all show the postulated primitive condition of the subgenital plates we can assume that the *bohemani* line became specialized in this one respect.

From the *bohemani*-like ancestor arose a closely similar form (Ancestor 2) in which the basal apodeme of the aedeagus extended laterally and the Xth segment had begun to expand. This stage is represented by *configuratus* and the *frauenfeldi* group of species all of which show only a slight development, if any, of the mesal margin of the subgenital plate. *D. configuratus* differs from the other species of the group by having a much shorter pygophore, a less well developed mesal lobe on the subgenital plates, the basal apodeme less well developed laterally, the arms of the connective much closer together and not reaching the base of the apical process and the aedeagus with much shorter apical processes, all of which suggests its earlier origin from the *frauenfeldi*/*altaicus* line.

*D. nigrifrons*, although specialized in the shape of its aedeagus, shows many primitive character conditions and undoubtedly arose very early on in the evolution of the genus, probably as a specialized offshoot between Ancestors 1 and 2. It also acquired the green coloration of the more advanced forms, apparently independent of the main line of evolution.

The next major step in the evolution of the genus, leading to Ancestor 3, was the elongation of the shaft of the aedeagus and the curving posteriorly of its apical portion plus the change in body colour from stramineous to pale green. This stage is represented by the two closely related species *alaicus* and *logvinenkoae* both of which still retain the primitive type of apical process to the style but show further development of the mesal margin of the subgenital plate. *D. alaicus* appears to retain the primitive type of basal apodeme to the aedeagus but this is undoubtedly a secondary reduction.

The next step, exemplified by Ancestor 4, was the elongation of the apical process of the style. Ancestor 4 itself gave rise to three main lines. One line lead to *orientalis*, *convenarum*, *limbatellus* and related species and showed little change from the earlier forms apart from the styles. *D. orientalis* shows the least modification of all and is clearly the most primitive form of this line. In the *limbatellus* group itself, comprising *limbatellus*, *kyrilli*, *sichotanus*, *kaszabi* and *bensoni*, the apical processes of the aedeagus became broad and leaf-like with a pair of small spur-like processes developing immediately basad of them. *D. bensoni*, in which the apical processes are still slender, is undoubtedly the primitive form of the group. *D. convenarum* differs from both *orientalis* and the *limbatellus* group in having a straight shaft to the aedeagus and is clearly a specialized line branching off somewhat earlier than the others and close to the *quadrivirgatus* group, which it resembles in the shape of the pygophore. A second line, derived from the first, acquired a second pair of apical processes on the aedeagus. The primitive condition of this line, in which the slender shaft of the aedeagus is retained, is represented by *quadrivirgatus*. The aedeagus subsequently became shortened and robust as seen in *quadricornis*, followed by the partial fusion or loss of the apical processes



as seen in *nigricans* and *penthopitta* respectively. The ancestor of these last three species also developed a major extension of the apical lobe of the subgenital plates. The lineage leading to *penthopitta* itself also developed a ventral extension to the atrium and a secondary reduction of the apical process of the style. The third line from Ancestor 4 lead to Ancestor 5, in which the basal apodeme of the aedeagus became long and narrow and the arms of the connective divergent and abruptly angled distally.

Ancestor 5 gave rise to two main lines. One line showed a marked increase in the length of the style relative to the connective, accompanied by a marked divergence of the arms of the connective itself. This line later branched into two, one branch retaining the slender apical processes to the aedeagus and leading to *evansi* and related species and the other, in which the apical processes were reduced, leading to *exsiliatus*, *causicus* and *tianshanicus*. The *evansi* line later gave rise to a line, represented by *abdominalis*, *temperei*, *laetitia*, *rustavelicus* and *monticola*, in which the apical processes became branched and the pygophore process lost. *D. monticola* became further specialized by the secondary reduction of the aedeagal processes. The second main line from Ancestor 5 lead to Ancestor 6, in which an additional pair of processes were developed at the apex of the aedeagus.

The condition present in Ancestor 6, with the additional processes still small, is preserved in the closely related species *intermedius* and *oseticus*. These processes later increased in size to approximate the length of the initial pair, a stage represented by *ciscaucasicus* and *admistus*, followed by the elongation of both pairs with the more lateral ones moving dorsally, as seen in *melichari*.

The sequence of events in the evolution of the genus as outlined above is illustrated in Text-fig. 139.

#### ORIGIN AND DISPERSAL

The evolution of the genus is seen to have taken place exclusively within the Palaearctic Region, only two species, *configuratus* and *evansi*, having succeeded in dispersing into the Nearctic Region. The distribution of the various species shows certain correlations with the successive stages of evolution suggesting, in each case, definite centres of radiation.

The more primitive forms, *bohemani*, *nigrifrons* and *frauenfeldi*, are all widely distributed throughout the region with several species, closely related to *frauenfeldi*, having originated in the more eastern parts. One lineage from the *frauenfeldi* stock migrated across the Bering Strait and gave rise to *configuratus*, which spread throughout Canada and the northern half of the United States.

Of the next major phase of evolution, although the primitive members *alaicus* and *logvinenkoae* are found only in the south central area of the U.S.S.R., the greater part of the development and radiation occurred in the western part of the region where the present day representatives are found. Only the *limbatellus* group appears to have successfully dispersed beyond the area and extended its range across the entire Palaearctic Region.

In contrast, the next and final phase of evolution occurred mainly in the more central and eastern parts of the region, the most highly specialized forms of all,

the descendents of Ancestor 6, having evolved exclusively in Caucasia. Only the widely distributed *abdominalis*, and its closely related European species *temperei*, *laetitia*, *rustavelicus* and *monticola*, occur in the western part of the region and only one species, *evansi*, has dispersed across the Bering Strait into the New World.

The dispersal of *configuratus* and *evansi* into the Nearctic Region clearly occurred on two separate occasions. *D. configuratus*, which is sufficiently distinct from its nearest Palaearctic relatives to be considered a separate species, must have dispersed at a much earlier period than *evansi* which, despite its widespread occurrence throughout the northern part of the Nearctic Region, is still morphologically unchanged from the eastern Palaearctic members of the species. These findings and conclusions are in line with the more primitive status and earlier origin of *configuratus*. The close morphological similarity of both forms to their Palaearctic relatives, however, and the absence of speciation within the New World suggests that both dispersals occurred in relatively recent times.

### DIPLOCOLENUS Ribaut

*Diplocoenus* Ribaut, 1946 : 82. Type-species: *Deltocephalus calceolatus* Boheman, by original designation.

Small species, 3–5 mm in length, pale green in colour with face, legs and venter dark brown, sometimes cream or stramineous with dark brown markings.

Head wider than pronotum; vertex  $1\frac{1}{2}$ –2 times longer medially than next eyes with anterior margin angularly rounded, slightly shorter medially than basal width between eyes, anterior margin shagreen and narrowly rounded to face, disc flat and glabrous; clypeus broad, shagreen; trans-clypeal suture distinct; clypellus broad with sides converging slightly to apex; gena next clypellus broad, approximating width of ocellular area; ocelli very small, separated from eyes by distance 2–3 times own diameter. Pronotum slightly shorter than vertex, lateral margins short, posterior margin shallowly concave. Fore wings long, appendix narrow, inner subapical cell closed, middle subapical cell slightly constricted, outer subapical cell elongate, slightly shorter than inner subapical. Tibia I with setal formula 2.2.2.1.

Male genitalia with pygophore robust, as wide as long or slightly longer or shorter than wide, emarginate dorsally to near midlength, tapering posteriorly and terminating usually in a short ventrally or posteriorly directed process, setae restricted to dorsal margin of lateral wall, with a large or small membranous or semi-membranous lobe-like expansion from latter in most species; Xth segment enlarged, globular with sides convex, sometimes narrow with sides parallel or divergent towards base, rarely attaining or exceeding apex of pygophore, sclerotised dorsally and laterally and usually also ventrally along posterior margin, without basal processes; subgenital plates triangulate, with deep incision laterally, the apex beyond incision finger-like and variable in length, a tooth on dorsal surface at base of incision, setae along ventrolateral margin and sometimes on ventral surface of finger-like apex, multiseriate or uniseriate, plates attaining or not attaining apex of pygophore, rarely exceeding; styles with apical process robust and triangulate or acutely elongate and curving laterally, with single row of teeth or undulations along posteroventral edge, lateral lobe well developed, rarely small, basal process long; connective large, length equal to or less than styles, rarely longer, arms convergent or closely parallel distally and fused over part of length or widely separated and divergent to near apex and then angled abruptly to midline; aedeagus with shaft elongate, rarely short and robust, directed dorsally and usually turned posteriorly at apex, terminating in one or two

pairs of apical processes, rarely one pair plus medial process, processes rarely fused, basal apodeme small and short or with dorsolateral corners produced laterally or long and narrow, gonopore apical or subapical.

**DIAGNOSIS.** The genus is readily distinguished from all other genera of Deltocephalinae, except *Anareia* Vilbaste, by the shape of the subgenital plates in the male. Although *Diplocolenus* and *Anareia* are similar in this respect they differ in the shape of the male pygophore.

**DISTRIBUTION.** The genus at the present day is distributed throughout the Palaearctic Region from Great Britain in the west to Japan in the east. It also extends from Scandinavia and northern Russia in the north to North Africa in the south. Although a few species occur throughout the major part of this range the majority are restricted to relatively small areas. Only two species have dispersed beyond the region into the northern part of the Nearctic Region.

### Subgenera

Although the genus is clearly monophyletic in origin and its evolution follows an orderly sequence of events, there are three well defined groups coinciding with significant changes in structure. The first and most primitive group has the shaft and apical processes of the aedeagus directed dorsally, the second has the shaft elongated and turned posteriorly at the apex and the third and most advanced group has, in addition, the arms of the connective divergent and abruptly angled distally. In order to draw attention to these three subdivisions each is accorded subgeneric rank, the first two being paraphyletic and the last holophyletic in the sense of Ashlock (1971).

### Subgenus *DIPLOCOLENUS* Ribaut

*Diplocolenus* subgenus *Diplocolemus* Ribaut, 1946 : 82. Type-species: *Deltocephalus calceolatus* Boheman, by original designation.

*Diplocolenus* subgenus *Verdanulus* Emeljanov, 1966 : 122. Type-species: *Jassus nigrifrons* Kirschbaum, by original designation. **Syn. n**

Stramineous in colour, sometimes marked with dark brown, rarely pale green with face, legs and venter dark brown to black.

Male genitalia with pygophore terminating posteriorly in a short posteriorly or postero-ventrally directed process; Xth segment small with sides parallel or enlarged and increasing in width towards base, apex basad or distad of apex of pygophore; subgenital plates with finger-like apex variable in length, attaining or exceeding apex of pygophore; styles with apical process robust and triangulate; connective with arms closely parallel distally and fused over part of length; aedeagus with shaft directed dorsally, a pair of apical processes directed dorsally in line with shaft and curving anteriorly at apex, basal apodeme short and narrow or with dorsolateral corners strongly produced laterally.

Included species: *bohemani* (Zetterstedt), *configuratus* (Uhler), *frauenfeldi* (Fieber), *fraternellus* (Baker), *tripartitus* (Kusnezov), *altaicus* Vilbaste, *ikumai* (Matsumura), *nigrifrons* (Kirschbaum).

Subgenus **ERDIANUS** Ribaut

*Diplocolemus* subgenus *Erdianus* Ribaut, 1952 : 281. Type-species: *Acocephalus sudeticus* Kolenati, by original designation.

*Diplocolemus* subgenus *Sabelanus* Ribaut, 1959 : 404. Type-species: *Deltocephalus nasti* Wagner, by original designation. **Syn. n.**

*Diplocolemus* subgenus *Gelidanus* Emeljanov, 1966 : 122. Type-species: *Cicada limbatella* Zetterstedt, by original designation. **Syn. n.**

Pale green, rarely marked with dark brown, face, venter and legs dark brown or black.

Male genitalia with pygophore terminating posteriorly in a short ventrally, posteriorly or ventroposteriorly directed process; Xth segment enlarged, globular, with sides strongly convex, apex basad or distad of apex of pygophore; subgenital plates with finger-like apex variable in length, shorter or longer than pygophore; styles with apical process acutely elongate, curving posterolaterally, rarely short and triangulate; connective with arms closely parallel distally and fused over part of length; aedeagus with shaft elongate, directed dorsally with apex turned posteriorly, rarely straight and directed dorsoposteriorly or short and robust, with one or two pairs of apical processes, the latter rarely fused, basal apodeme short with dorso-lateral corners strongly produced laterally, atrium rarely produced ventrally.

Included species: *alaicus* Emeljanov, *logvinenkoae* Emeljanov, *orientalis* (Ribaut), *limbatellus* (Zetterstedt), *sichotanus* Anufriev, *kyrilli* Emeljanov, *kaszabi* Dlabola, *bensoeni* (China), *convenarum* (Ribaut), *quadrivirgatus* (Horvath), *quadricornis* Ribaut, *penthopitta* (Walker), *nigricans* (Kirschbaum).

Subgenus **VERDANUS** Oman

*Verdanus* Oman, 1949 : 165. Type-species: *Deltocephalus evansi* Ashmead, by original designation.

Pale green with face, venter and legs dark brown or black.

Male genitalia with pygophore with or without a short ventrally directed process posteriorly; Xth segment enlarged, globular, with sides strongly convex, not exceeding apex of pygophore; subgenital plates with finger-like apex slightly variable in length, shorter than pygophore; styles with apical process acutely elongate, curving posterolaterally; connective with arms divergent distally and abruptly angled to midline; aedeagus with shaft elongate, directed dorsally with apex turned posteriorly, with one or two pairs of apical processes, basal apodeme long and narrow.

Included species: *evansi* (Ashmead), *abdominalis* (Fabricius), *temperei* Ribaut, *laetitia* Servadei, *rustavelicus* Logvinenko, *monticola* Linnavuori, *exsiliatus* Emeljanov, *caucasicus* Emeljanov, *tianshanicus* Emeljanov, *intermedius* Emeljanov, *oseticus* Emeljanov, *ciscaucasicus* Emeljanov, *admistus* Logvinenko, *melichari* Dlabola.

## KEY TO SUBGENERA

- 1 Aedeagus with shaft directed dorsally, not turned posteriorly at apex, apical processes parallel and directed dorsally in line with shaft, with apex curving anteriorly, never posteriorly, basal apodeme small or strongly produced laterally; styles with apical process robust, triangulate; connective with arms parallel distally and fused over part of length . . . . . **DIPLOCOLEMUS**
- Aedeagus with shaft directed dorsally with apex turned posteriorly, rarely straight and directed dorsoposteriorly, apical processes divergent, sometimes parallel, rarely

- fused, variously directed at angle to shaft, basal apodeme strongly produced laterally or long and narrow; styles with apical process acutely elongate, rarely short, curving laterally; connective with arms parallel distally and fused over part of length or divergent distally and abruptly angled to midline . . . . . 2
- 2 Aedeagus with basal apodeme strongly produced laterally; connective with arms parallel distally and fused over part of length . . . . . **ERDIANUS**
- Aedeagus with basal apodeme long and narrow; connective with arms divergent distally and abruptly angled to midline . . . . . **VERDANUS**

The subgenera proposed above are similar to those suggested by Ribaut (1952 : 281) although the actual grouping of the species differs. He separated *Erdianus* and *Verdanus* on the ventral prolongation of the atrium, which has been shown above to be a highly specialized character of no significance to the main evolutionary trends, and consequently placed *convenarum*, *orientalis* and *obenbergeri* (= *bensoni*) in *Verdanus* rather than *Erdianus* where they belong. The subgenus *Sabelanus* proposed later by Ribaut (1959 : 404) to include those species, *nasti* (= *quadrivirgatus*) and *quadricornis*, with two pairs of apical processes on the aedeagus is clearly an unnatural group. Both species, as shown above, are simply more primitive forms of the *penthopitta* line and also belong to *Erdianus* of which *sudeticus* (= *penthopitta*) is the type-species.

Emeljanov (1966 : 122), using principally the characters of the subgenital plates, suggested a finer division of the genus than that proposed herein and described subgenera for both the *limbatellus* group and *nigrifrons*. His remaining subgenera, however, with the exception of *Calidanus* which belongs to the genus *Anareia*, are as proposed above but being based solely on characters of the subgenital plates contain erroneous groups of species. *D. alaicus*, *logvinenkoae*, *nasti* (= *quadrivirgatus*), *orientalis* and *convenarum* are all included in *Verdanus* rather than *Erdianus* where they belong.

KEY TO SPECIES

The key is to males only and is based mainly on the genitalia. Females can be identified only by association with the males.

Males of *fraternellus* are not known and this species is not included in the key. According to Vilbaste (1969 : 2) it is closely related to *frauenfeldi* or *tripartitus*. *D. ikumai* is also omitted since specimens were not available for the present study and the description given by Vilbaste (1969 : 3) makes it difficult to distinguish with certainty from the closely related species *frauenfeldi* and *altaicus*.

- 1 Aedeagus with shaft not turned posteriorly at apex, terminating in two parallel processes directed dorsally in line with shaft, their apices turned slightly anteriorly, never posteriorly, basal apodeme small or strongly produced laterally (Text-figs 84-93); styles with apical processes robust, triangulate (Text-fig. 69); connective with arms parallel distally and fused over part of length (Text-fig. 68); colour cream or stramineous usually with fuscous markings, if pale green then Xth segment small with sides parallel (Text-fig. 11) . . . . . 2

- Aedagus with shaft turned posteriorly at apex (Text-fig. 94), rarely straight and then with apical process of styles elongate and acute (Text-fig. 76), shaft terminating in two, three or four divergent processes, sometimes parallel, rarely fused, variously directed at angle to shaft but never in line with latter, basal apodeme strongly produced laterally (Text-fig. 99) or long and narrow (Text-fig. 120); styles with apical process elongate and acute (Text-fig. 74), rarely short; connective with arms parallel distally and fused over part of length (Text-fig. 72) or divergent and abruptly angled to midline (Text-fig. 80); colour pale green, rarely extensively marked with dark brown . . . . . 7
- 2 (1) Subgenital plates with finger-like apex approximately  $2\frac{1}{2}$  times its basal width, exceeding length of plate basad of incision (Text-fig. 46) . . . . . *bohemani* (p. 373)
- Subgenital plates with finger-like apex wider than long (Text-fig 48) or absent (Text-fig. 47), much shorter than length of plate basad of incision . . . . . 3
- 3 (2) Subgenital plates with finger-like apex absent, obliquely truncate apically towards midline and base (Text-fig. 47) . . . . . *configuratus* (p. 374)
- Subgenital plates with finger-like apex present, sometimes very small but apex never obliquely truncate (Text-figs 48-50) . . . . . 4
- 4 (3) Colour pale green with apex of fore wings fuscous . . . . . *nigrifrons* (p. 378)
- Colour stramineous or cream, marked with dark brown . . . . . 5
- 5 (4) Fore wings with broad transverse yellow band near mid-length *tripartitus* (p. 376)
- Fore wings without broad transverse yellow band near mid-length . . . . . 6
- 6 (5) Pygophore process directed ventroposteriorly, not reaching level of ventral margin of pygophore, ventral margin of pygophore immediately basad of process broadly rounded (Text-fig. 28); subgenital plates not reaching apex of pygophore, finger-like apex extending distad of dorsal tooth (Text-fig. 48).  
*frauenfeldi* (p. 375)
- Pygophore process directed ventrally, extending ventrad of ventral margin of pygophore, ventral margin of pygophore immediately basad of process flat (Text-fig. 29); subgenital plates reaching apex of pygophore, finger-like apex not extending distad of dorsal tooth (Text-fig. 49) . . . . . *altaicus* (p. 376)
- 7 (1) Aedeagus with basal apodeme short and strongly produced laterally (Text-fig. 97) or with apical process of style short and triangulate (Text-fig. 71), aedeagus sometimes short and robust (Text-figs 114 & 116); connective with arms parallel distally and fused along part of length (Text-fig. 77) . . . . . 8
- Aedeagus with basal apodeme long and narrow (Text-fig. 120), aedeagus and apical process of style always elongate (Text-figs 79 & 119); connective with arms divergent distally and abruptly angled to midline (Text-fig. 80) . . . . . 20
- 8 (7) Aedeagus elongate, with one pair of apical processes directed dorsally or anteriorly (Text-fig. 94), a pair of lateral subapical spur-like processes sometimes present (Text-fig. 103) . . . . . 9
- Aedeagus elongate or robust, with one or two pairs of apical processes or with apex expanded into broad umbrella-like plate (Text-fig. 116), if one pair of apical processes then aedeagus robust and processes directed ventrally (Text-fig. 114), subapical spur-like processes never present . . . . . 17
- 9 (8) Aedeagus with shaft straight (Text-fig. 100) . . . . . *convenarum* (p. 383)
- Aedeagus with shaft turned posteriorly at apex (Text-fig. 98) . . . . . 10
- 10 (9) Pygophore with posterior processes short and robust, arising from extreme posteroventral corner and directed ventrally (Text-fig. 32) or posteriorly (Text-fig. 34), sometimes vestigial; apical processes of aedeagus slender (Text-fig. 97) or elongate and leaf-like (Text-fig. 103) . . . . . 11
- Pygophore with posterior processes short and slender, arising from posterior margin and directed posteroventrally (Text-fig. 33); apical processes of aedeagus short and triangulate (Text-fig. 99) . . . . . *orientalis* (p. 379)

- 11 (10) Pygophore processes directed posteriorly or vestigial; aedeagus with a pair of lateral subapical spur-like processes immediately basad of apical processes (Text-fig. 103) . . . . . 12
- Pygophore processes directed ventrally; aedeagus without subapical spur-like processes (Text-fig. 97) . . . . . 16
- 12 (11) Aedeagus with apical processes slender (Text-fig. 110); pygophore processes vestigial . . . . . *benso*ni (p. 382)
- Aedeagus with apical processes broad and leaf-like (Text-fig. 106); pygophore processes short and robust . . . . . 13
- 13 (12) Aedeagus with apical processes broadly cleft apically (Text-fig. 109). . . . . *kaszabi* (p. 382)
- Aedeagus with apical processes narrowly acute apically (Text-fig. 102) . . . . . 14
- 14 (13) Aedeagus with apical processes diametrically opposite each other, directed laterally and curving anteriorly, subapical processes directed ventrally, shaft relatively broad (Text-figs 106 & 107) . . . . . *sichotanus*<sup>1</sup> (p. 381)
- Aedeagus with apical processes less divergent, not diametrically opposite, directed laterally and curving dorsally (Text-fig. 104) or anterodorsally (Text-fig. 102), subapical processes directed laterally or dorsally, shaft relatively narrow . . . . . 15
- 15 (14) Aedeagus with apical processes curving anterodorsally, subapical processes directed laterally, shaft with sides straight (Text-figs 102 & 103). . . . . *limbatellus*<sup>1</sup> (p. 380)
- Aedeagus with apical processes curving dorsally, subapical processes directed dorsally, shaft with sides slightly convex near midlength (Text-figs 104 & 105) . . . . . *kyrilli*<sup>1</sup> (p. 381)
- 16 (11) Aedeagus with shaft slender, apical processes directed dorsally, basal apodeme plate-like with dorsolateral corners produced dorsolaterally (Text-figs 94 & 95) . . . . . *alaicus* (p. 378)
- Aedeagus with shaft broad, apical processes directed anteriorly, basal apodeme V-shaped (Text-figs 96 & 97) . . . . . *logvinenkoae* (p. 379)
- 17 (8) Aedeagus with two pairs of apical processes . . . . . 18
- Aedeagus with one pair of apical processes or with apex expanded into broad umbrella-like plate . . . . . 19
- 18 (17) Aedeagus with shaft short, robust and straight, apical processes robust, the dorsal pair approximately half length of ventral pair . . . . . *quadricornis* (p. 385)
- Aedeagus with shaft slender with apex turned posteriorly, apical processes slender, the dorsal and ventral pair of equal length (Text-figs 112 & 113). . . . . *quadrivirgatus* (p. 384)
- 19 (17) Aedeagus with a pair of short, ventrally directed, apical processes (Text-figs 114 & 115) . . . . . *penthopitta* (p. 386)
- Aedeagus with apex expanded into broad, anteriorly incised, umbrella-like plate (Text-figs 116-118) . . . . . *nigricans* (p. 385)
- 20 (7) Aedeagus with one pair of apical processes, branched or unbranched (Text-figs 120 & 122), rarely with additional unpaired medial process apically (Text-figs 129 & 130) . . . . . 21
- Aedeagus with two pairs of apical processes (Text-figs 131 & 132), never branched, sometimes fused basally (Text-figs 135 & 136), additional medial process never present . . . . . 29
- 21 (20) Aedeagus with apical processes unbranched . . . . . 22
- Aedeagus with apical processes branched . . . . . 25
- 22 (21) Aedeagus with paired apical processes long and slender (Text-fig. 120). . . . . *evansi* (p. 387)

<sup>1</sup> These three species are very closely related and may in fact be the same species. The differences referred to in the above key are slight and intermediate forms may be found.

- Aedeagus with paired apical processes small and triangulate (Text-fig. 128) . . . . . 23
- 23 (22) Aedeagus with additional unpaired medial process apically (Text-figs 129 & 130).  
*tianshanicus* (p. 391)
- Aedeagus without additional unpaired process apically . . . . . 24
- 24 (23) Aedeagus with shaft directed dorsally with apical half turned posteriorly  
 (Text-fig. 127) . . . . . *exsiliatus* (p. 390)
- Aedeagus with shaft directed dorsally with slight anteriorly directed kink at  
 midlength, apical half not turned posteriorly . . . . . *caucasicus*<sup>2</sup> (p. 391)
- 25 (21) Aedeagus with apical processes long and slender, portions basad and distad of  
 branching of approximately equal width (Text-fig. 122) . . . . . 26
- Aedeagus with apical processes short and robust, portion basad of branching  
 approximately twice width of distal portion (Text-figs 125 & 126).  
*monticola* (p. 390)
- 26 (25) Aedeagus with dorsal and ventral branches of apical processes of approximately  
 equal length (Text-fig. 121) . . . . . 27
- Aedeagus with dorsal branch of apical processes approximately half length of  
 ventral branch (Text-fig. 123) . . . . . 28
- 27 (26) Aedeagus with dorsal and ventral branches of apical processes at approximately  
 right angles to each other, the dorsal branch directed anteriorly and the  
 ventral branch directed ventrally (Text-figs 121 & 122) . . . . . *abdominalis* (p. 388)
- Aedeagus with dorsal and ventral branches of apical processes in an approxi-  
 mately straight line, the dorsal branch directed dorsally and the ventral  
 branch directed ventrally . . . . . *temperei* (p. 389)
- 28 (26) Aedeagus with distal half of shaft much thicker in lateral aspect than basal  
 half, shaft in posterior aspect tapering gradually to apex (Text-figs 123 & 124).  
*laetitiae* (p. 389)
- Aedeagus with shaft of uniform width in lateral aspect, shaft in posterior  
 aspect with slight enlargement on each side near midlength.  
*rustavelicus*<sup>3</sup> (p. 390)
- 29 (20) Aedeagus with medial, more posterior, pair of apical processes much shorter  
 than lateral, more basad pair (Text-figs 131 & 132) . . . . . 30
- Aedeagus with two pairs of apical processes of approximately equal length  
 (Text-figs 135 & 138) . . . . . 31
- 30 (29) Aedeagus with medial, more posterior, pair of apical processes very short, their  
 length equal to or only slightly greater than their basal width (Text-fig. 134).  
*oseticus* (p. 392)
- Aedeagus with medial, more posterior, pair of apical processes longer, their  
 length approximately three times their basal width (Text-fig. 132).  
*intermedius* (p. 392)
- 31 (29) Aedeagus with medial, more posterior, pair of apical processes triangulate,  
 each fused to adjacent more lateral process over basal half, the more lateral  
 pair of processes directed ventrolaterally (Text-figs 135 & 136) . . . . . 32
- Aedeagus with both pairs of apical processes slender and independent of each  
 other, the more lateral pair of processes directed dorsolaterally and curving  
 ventrolaterally (Text-figs 137 & 138) . . . . . *melichari* (p. 394)
- 32 (31) Aedeagus with medial, more posterior, pair of apical processes fused to each  
 other over their basal half, basal apodeme with small denticle on each lateral  
 margin . . . . . *admistus* (p. 393)

<sup>2</sup> Specimens of *caucasicus* were not available for study and the differences referred to in the above key between this species and *exsiliatus* are based on illustrations given by Emeljanov (1962 : 179, figs 90-91).

<sup>3</sup> Specimens of *rustavelicus* were not available for study and the differences referred to in the above key between this species and *laetitiae* are based on illustrations given by Logvinenko (1971 : 591, fig. 2).



- Aedeagus with medial, more posterior, pair of apical processes not fused to each other over their basal half, basal apodeme without small denticles (Text-figs 135 & 136) . . . . . *ciscaucasicus* (p. 393)

## Description of Species

*Diplocolenus (Diplocolenus) bohemani* (Zetterstedt)

(Text-figs 1, 2, 7, 26, 46, 65, 84 &amp; 85)

*Cicada bohemani* Zetterstedt, 1840 : 290. LECTOTYPE ♂, NORWAY: Dovre [not Vaage as stated by Zetterstedt] (*Boheman*) (UZI, Lund), here designated [examined].

*Deltocephalus calceolatus* Boheman, 1847 : 23. LECTOTYPE ♂, SWEDEN: Uppland (*Boheman*) (NR, Stockholm), here designated [examined].

*Deltocephalus tiaratus* Fieber, 1869 : 204. LECTOTYPE ♂, no data (MNHN, Paris), here designated [examined]. **Syn. n.**

Length: ♂ 3.7-4.1 mm (mean 3.9 mm); ♀ 4.3-4.6 mm (mean 4.4 mm).

Colour of vertex pale brown with midline and anterior and lateral margins cream, a narrow dark brown line extending along anterior margin on each side between apex and eye; face stramineous, clypeus brown, with a parallel series of transverse lines on each side of midline cream; pronotum pale brown with midline and two longitudinal lines on each side cream; fore wings stramineous, veins whitish bordered with dark brown, apical margin dark brown; legs and venter stramineous marked with brown; whole body sometimes pale stramineous without markings.

Male genitalia with pygophore slightly longer than wide, terminating posteroventrally in a short slender ventrally directed process, membranous expansion from dorsal margin very narrow; Xth segment with sides slightly divergent towards base, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with length of finger-like apex approximately 2½ times its basal width and exceeding length of part basad of incision, a multi-seriate row of setae along its ventral surface, lateral row of setae uniseriate, plates exceeding apex of pygophore; styles with apical process short, robust, lateral lobe well developed; connective longer than styles, arms parallel distally and fused over one third total length; aedeagus with shaft short, slender, turned dorsad near midlength and terminating in a pair of long slender dorsally directed processes curving anterodorsally at their midlength, basal apodeme short with dorsolateral corners produced slightly dorsolaterally.

DISTRIBUTION. Scandinavia, Europe, North Africa and U.S.S.R.

## MATERIAL STUDIED.

Lectotype ♂ and paralectotypes of *Cicada bohemani* Zetterstedt (UZI, Lund); lectotype ♂ and paralectotypes of *Deltocephalus calceolatus* Boheman (NR, Stockholm); lectotype ♂ and paralectotypes of *Deltocephalus tiaratus* Fieber (MNHN, Paris).

ITALY: 1 ♂, Molveno, -.viii.1931 (*Grey*) (BMNH). AUSTRIA: 1 ♂, 2 ♀, Tyrol, Landeck, -.vi.1957 (*Day & Ward*) (BMNH); 1 ♂, 1 ♀, Carinthia, Raibl (*Eger*) (BMNH). CZECHOSLOVAKIA: 2 ♀, Moravia (*Eger*) (BMNH). BULGARIA: 2 ♂, m. Rila, 8-12.viii.1939 (*Lindberg*) (BMNH). FINLAND: 1 ♂, Suomi EH Lammi, 20.vi.1958 (*Linnavuori*) (BMNH); 1 ♂, Suomi St. Säkyliä, 21.vi.1948 (*Linnavuori*) (LC, Raisio).

The type-series of *Cicada bohemani* Zetterstedt, deposited in the UZI, Lund, consists of one male labelled 'C. Bohemanni. ♂. Dovre' and two males and two

females without data, all of which were examined. The labelled male is here designated as lectotype and the other four specimens as paralectotypes.

The type-series of *Deltocephalus calceolatus* Boheman, deposited in the NR, Stockholm, and consisting of three males and four females labelled 'Upl.' and 'Bhn' and one female labelled 'Nv. alp.' and 'Bhn', was examined. In the original description Boheman (1847: 23) gives the data of the syntypes as 'Tollare in Wermdön d.28 Junii 1846' and 'Westrogothia et Norvegia alpina'. A male is here designated as lectotype and the other seven specimens as paralectotypes.

The type-series of *Deltocephalus tiaratus* Fieber, deposited in the MNHN, Paris, consists of one male without data, one female labelled 'Bamberg', one female labelled 'Lautaret', one female labelled 'Srkoutsk' and one specimen with the apex of the abdomen missing and without data. All these specimens were examined and the male is here designated as lectotype and the others as paralectotypes.

*Deltocephalus calceolatus* was originally included in *Diplocolenus* by Ribaut (1946: 82) and designated as the type-species. It had been synonymized earlier with *bohemani* by Puton (1874: 229) and considered by subsequent workers as a subspecies. Ribaut, however, did not mention *bohemani* in his new genus and it was Ossiannilsson (1947: 153) who first transferred *bohemani* to *Diplocolenus*. *Deltocephalus tiaratus* was first transferred to *Diplocolenus* by Ribaut (1952: 284).

This species is the most primitive member of the genus and occurs throughout the Palaearctic Region.

### *Diplocolenus (Diplocolenus) configuratus* (Uhler)

(Text-figs 8, 27, 47, 70, 86 & 87)

*Deltocephalus configuratus* Uhler, 1878: 511. LECTOTYPE ♂, U.S.A.: Montana, Milk River, 1873-74 (*Coues*) (USNM, Washington), here designated [examined].

Length: ♂ 3.3-3.8 mm (mean 3.5 mm); ♀ 3.7-4.3 mm (mean 3.9 mm).

Colour as in *frauenfeldi*.

Male genitalia with pygophore wider than long, terminating posteroventrally in a short posteriorly directed process, a narrow membranous expansion from dorsal margin; Xth segment with sides strongly divergent towards base, exceeding apex of pygophore, sclerotized over major part of ventral surface; subgenital plates with apex obliquely truncate towards midline and base, the medial margin approximately one third length of lateral margin, latter terminating in a dorsally directed tooth, a short row of setae ventrally on medial margin, lateral row of setae multiseriate, plates exceeding apex of pygophore; styles with apical process robust, triangulate, lateral lobe small; connective shorter than styles, arms parallel distally and fused over only short part of length; aedeagus with shaft short, slender, directed dorsoposteriorly and terminating in a pair of short, parallel, dorsally directed processes, basal apodeme short with dorsolateral corners produced dorsolaterally.

DISTRIBUTION. Canada and northern U.S.A.

MATERIAL STUDIED.

Lectotype ♂ of *Deltocephalus configuratus* Uhler (USNM, Washington).

CANADA: 1 ♂, Saskatchewan, Saskatoon, 13.vi.1949 (*Brooks*); 2 ♂, 1 ♀, Quebec, Hudson Heights, 24-30.vii.1956 (*Lindberg*); 1 ♀, Quebec, Hudson Heights,

25-31.viii.1956 (*Lindberg*); 1 ♂, Labrador, Hopedale, 8.viii.1926 (*Perrett*). U.S.A.: 1 ♂, Pennsylvania, Charter Oak, 18.vi.1918 (*Knull*); 1 ♂, Pennsylvania, Charter Oak, 18.vi.1918 (*Kirk*); 1 ♀, Pennsylvania, Harrisburg, 8.vii.1917 (*Sanders*); 21 ♂, 6 ♀, New Hampshire, Peterborough, 10.vi.1959 (*Zimmerman*); 1 ♀, Colorado, Walden, 20.viii.1931 (*Beamer*); 1 ♀, Utah, Duchesne Co., Indian Canyon, 15.vii.1964 (*Knowlton*); 1 ♂, Utah, Castle Dale, 17.vii.1964 (*Knowlton*). All in BMNH.

The type-series of this species deposited in the USNM, Washington, consists of one male, two females and one specimen without an abdomen.<sup>4</sup> The male alone was examined and is here designated as lectotype.

This species was transferred to *Diplocolenus* by Oman (1949: 166) and is the only species of the genus endemic to the Nearctic Region. It is undoubtedly an early offshoot of the *frauenfeldi/altaicus* line.

### *Diplocolenus (Diplocolenus) frauenfeldi* (Fieber)

(Text-figs 3, 4, 9, 28, 48, 69, 88 & 89)

*Deltocephalus frauenfeldi* Fieber, 1869: 206. LECTOTYPE ♂, AUSTRIA, no further data (MNHN, Paris), here designated [examined].

Length ♂ 3.2-3.5 mm (mean 3.3 mm); ♀ 3.8-4.1 mm (mean 3.9 mm).

Colour of vertex cream with two triangular patches at apex, a patch on disc on each side of midline and two smaller patches on posterior margin brown; face stramineous or cream marked with brown, clypeus pale brown with a parallel series of transverse stripes cream; pronotum cream washed with pale brown with small dark brown patches over anterior half, midline and two longitudinal lines on each side sometimes whitish; scutellum cream with medial area brown; fore wings pale stramineous, veins whitish bordered with brown, apical margin brown; venter and legs stramineous.

Male genitalia with pygophore as wide as long, terminating posteroventrally in a short slender ventroposteriorly directed process, without membranous expansion from dorsal margin; Xth segment with sides slightly convex, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with finger-like apex wider than long and with a small group of setae on ventral surface, lateral row of setae multiseriate, plates not reaching apex of pygophore; styles with apical process robust, triangulate, lateral lobe well developed; connective shorter than styles, arms convergent distally and fused over part of length; aedeagus with shaft short, slender, turned dorsad at midlength and terminating in a pair of long slender parallel processes directed dorsally and turning anterodorsally at their midlength, basal apodeme short with dorsolateral corners strongly produced dorsolaterally.

DISTRIBUTION. Europe and southern U.S.S.R.

MATERIAL STUDIED.

Lectotype ♂ and paralectotypes of *Deltocephalus frauenfeldi* Fieber (MNHN, Paris).

U.S.S.R.: 2 ♂, 1 ♀, Siberia, Zalagansk, Charinzovka, 6.vii.1932 (*Zachvatkin*) (BMNH); 4 ♂, 2 ♀, Kurile Islands, Shikotan, 13.viii.1971 (*Petrova*) (GAA, Gorky). AUSTRIA: 2 ♀, Donau-Au (*Eger*) (BMNH); 1 ♂, Leithagebirge, Zeilerberg (*Franz*) (WW, Hamburg); 1 ♀, Bad Vöslau, Nieder-Donau (WW, Hamburg).

<sup>4</sup> Dr J. P. Kramer, personal communication.

The type-series of *Deltocephalus frauenfeldi* Fieber, deposited in the MNHN, Paris, consists of one male labelled 'Autriche', one male and two females without data and one female labelled 'Embrun', all of which were examined. The male labelled 'Autriche' is here designated as lectotype and the remaining specimens as paralectotypes.

This species was originally included in the genus by Ribaut (1946 : 85).

***Diplocolenus (Diplocolenus) fraternellus* (Baker)**

*Deltocephalus fraternus* Matsumura, 1915 : 166. 3 ♀ syntypes, KOREA: Berg Chohaku (*Ikuma*) (EIHU, Sapporo) [not examined]. [Primary homonym of *Deltocephalus fraternus* Ball, 1911 : 201.]

*Deltocephalus fraternellus* Baker, 1925 : 537. [Replacement name for *Deltocephalus fraternus* Matsumura, 1915.]

Vilbaste (1969 : 2) transferred this species to *Diplocolenus* following examination of the three female syntypes and considered it to be closely related to *frauenfeldi* or *tripartitus*. The male is not known, the figures given by Emeljanov (1966 : 126, figs 95-96) being *Futasujinus candidus* (Matsumura) (Vilbaste, 1967 : 48).

DISTRIBUTION. Korea and Japan.

MATERIAL STUDIED. No specimens were available for the present study.

***Diplocolenus (Diplocolenus) tripartitus* (Kusnezov)**

*Deltocephalus tripartitus* Kusnezov, 1929 : 179. Holotype ♂, U.S.S.R.: Transbaikalia, Troizkosavskij Rayon, River Tschikoi, Scharagol, 1.vii.1928 (*Lukjanovitsh*) (ZI, Leningrad) [not examined].

*Deltocephalus kiritshenkoi* Zachvatkin, 1953 : 248. ♂ ♀ syntypes, MONGOLIA: banks of Lake Kosogol, 3 ♀, Santa Ara on western banks, 30.vii.1903, 1 ♂, 1 ♀, Santa-Tologoy, 28.vii.1903, 1 ♀, banks between rivers Dzhagluik and Khatchim, -.vii.1903 (*Elpat'evski*) (ZM, Moscow) [not examined].

This species is redescribed and the aedeagus illustrated by Dlabola (1965 : 123), who transferred it to *Diplocolenus* and placed *Deltocephalus kiritshenkoi* as its synonym. From the shape of the aedeagus it is closely related to *frauenfeldi* but differs by the possession of a broad transverse yellow band across the middle of the fore wings.

DISTRIBUTION. Mongolia and Transbaikalia, U.S.S.R.

MATERIAL STUDIED. No specimens were available for the present study.

***Diplocolenus (Diplocolenus) altaicus* Vilbaste stat. n.**

(Text-figs 10, 29, 49, 68, 90 & 91)

*Diplocolenus frauenfeldi altaicus* Vilbaste, 1965 : 72. Holotype ♂, U.S.S.R.: Altai, Khaisin, 30.vii.1959 [not 1.viii.1959 as stated by Vilbaste] (*Vilbaste*) (IZB, Tartu) [examined].

Length: ♂ 3.20-3.28 mm (mean 3.24 mm).

Colour as in *frauenfeldi* but with venter, legs and basal half of fore wings dark brown.

Male genitalia with pygophore as long as wide, terminating posteroventrally in a slender ventrally directed process, with a very narrow membranous expansion from dorsal margin; Xth segment with sides divergent towards base, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with apex truncate and shallowly concave medially, lateral margin terminating in a small dorsally directed tooth, a group of setae on ventral surface against medial margin, lateral row of setae multiseriate, plates reaching to apex of pygophore; styles with apical process robust and triangulate, lateral lobe well developed; connective shorter than styles, arms convergent distally and fused over one third total length; aedeagus with shaft short, slender, turned dorsally at midlength and terminating in a pair of long, slender, parallel processes, directed dorsally and turning anterodorsally at midlength, basal apodeme short with dorsolateral corners strongly produced dorsolaterally.

DISTRIBUTION. Mongolia and Altayskaya Province, U.S.S.R.

MATERIAL STUDIED.

Holotype ♂ of *Diplocoenus frauenfeldi altaicus* Vilbaste (IZB, Tartu).

U.S.S.R.: 1 ♂, Altayskaya Province, Kurayskiy mountain range, 2.vii.1969 (*Emeljanov*) (BMNH).

This species differs from *frauenfeldi* in colour and in the shape of the subgenital plates and pygophore process. It is here considered sufficiently distinct to be a separate species.

*Diplocoenus (Diplocoenus) ikumai* (Matsumura)

*Deltocephalus ikumai* Matsumura, 1911 : 29. 8 syntypes, U.S.S.R.: Sakhalin, Korsakov (*Ikuma*) (EIHU, Sapporo) [not examined].

This species was transferred to *Diplocoenus* by Ishihara (1966 : 39) on the basis of specimens from the Kurile Islands. The illustrations given by Ishihara, however, suggest that the material before him was in fact *frauenfeldi*. Moreover, four male and two female specimens from the Kurile Islands examined in the present study and identical to Ishihara's illustrations also appear to be *frauenfeldi*. Vilbaste (1969 : 3) who studied six female syntypes from Sakhalin, together with a male and six females from the same locality, showed *ikumai* to be a form very similar to *frauenfeldi* but with a relatively shorter pygophore and with the pygophore process directed more ventrally.

DISTRIBUTION. Sakhalin and Primorsk Territory, U.S.S.R.

MATERIAL STUDIED. No specimens were available for the present study.

The close similarity between *frauenfeldi*, *ikumai*, *tripartitus* and *fraternellus* suggests that they may all be the same species, although longer series throughout their respective ranges are required for confirmation. Only *frauenfeldi* in this group is widely distributed throughout the Palaearctic Region, the other species, together with the related species *altaicus*, having restricted distributions in the more eastern parts of the region.

***Diplocolenus (Diplocolenus) nigrifrons*** (Kirschbaum)

(Text-figs 11, 30, 50, 66, 92 and 93)

*Jassus (Deltocephalus) nigrifrons* Kirschbaum, 1868 : 139. ♀ type(s) [number not stated], AUSTRIA (Mayr) (? NM, Wiesbaden) [not examined].

*Deltocephalus ensatus* Then, 1897 : 109. ♂♀ syntypes [number not stated], AUSTRIA: Kärnten, Greifenburg, July & August (? SL, Graz) ([not examined]).

*Diplocolenus parcanicus* Dlabola, 1948 : 6. Holotype ♂, CZECHOSLOVAKIA: Slovakia, Parkán, -vii.1948 (Obenberger) (NM, Prague) [not examined].

Length: ♂ 2.60–3.90 mm (mean 3.30 mm); ♀ 3.60–3.82 mm (mean 3.73 mm).

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia with pygophore as long as wide, terminating posteriorly in a long stout ventrally directed blade-like process, with a small membranous expansion from dorsal margin; Xth segment with sides parallel, length approximately  $1\frac{1}{2}$  times width, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with apex truncate with shallow medial depression, lateral margin terminating adjacent to depression in a small dorsal tooth, a small number of setae on medial edge of ventral surface immediately basad of apex and with uniseriate row of setae laterally, plates reaching to apex of pygophore; styles with apical process robust, lateral lobe well developed; connective equal in length to styles, arms parallel distally and fused along part of length; aedeagus with shaft short, directed dorsally and terminating in a pair of short anteriorly directed processes, their bases expanded slightly, a pair of short slender anteriorly directed processes sometimes present at apex between larger pair, basal apodeme short with dorsolateral corners produced slightly dorsolaterally.

DISTRIBUTION. Europe, Scandinavia, U.S.S.R. and Japan.

## MATERIAL STUDIED.

CZECHOSLOVAKIA: 1 ♂, 2 ♀, Slovakia, Parkán, -vii.1948 (Obenberger) (paratypes of *Diplocolenus parcanicus* Dlabola) (NM, Prague). BULGARIA: 1 ♂, Pancarevo, 15.vii.1956 (Hoberlandt) (NM, Prague). U.S.S.R.: 1 ♂, Kazakstan, Akmolinsk Province, Kapetau, 28.v.1957 (Emeljanov) (BMNH); 1 ♂, 1 ♀, Ukraine, Askaniya Nova, 30.v.1926 (Znoiko) (BMNH).

*Deltocephalus ensatus* was first synonymized with *nigrifrons* by Horvath (1903 : 557). *Deltocephalus nigrifrons* was transferred to *Diplocolenus* by Dlabola (1954 : 75) who in the same work (p. 213) listed *parcanicus* as its synonym for the first time.

This is a widely distributed species retaining many primitive characters yet specialized in colour and in the shape of the aedeagus. It does not appear to be closely related to any other species but undoubtedly arose early in the evolution of the genus.

***Diplocolenus (Erdianus) alaicus*** Emeljanov

(Text-figs 12, 31, 51, 71, 94 and 95)

*Diplocolenus alaicus* Emeljanov, 1966 : 123. Holotype ♂, U.S.S.R.: Tadzhikistan, south slope of Petra I range, Sikat, 13.vi.1963 (Soboleva) (ZI, Leningrad) [not examined].

Length: ♂ 4.7 mm.

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia with pygophore as wide as long, terminating posteroventrally in a short robust ventrally directed process and with a large membranous expansion from dorsal margin; Xth segment with sides convex, exceeding apex of pygophore, sclerotized ventrally on posterior margin; subgenital plates with finger-like apex approximately as long as wide with a short uniseriate row of setae on ventral surface, lateral row of setae multiseriate, plates exceeding apex of pygophore; styles with apical process robust and triangulate, lateral lobe small; connective shorter than styles, arms parallel distally and fused over short distance of length; aedeagus with shaft slender, directed dorsally with apical third turned posteriorly, terminating in a pair of short slender dorsally directed and divergent processes, basal apodeme short and broad, plate-like with dorsolateral corners produced dorsolaterally.

DISTRIBUTION. Tadzhikistan Republic, U.S.S.R.

MATERIAL STUDIED.

U.S.S.R.: 1 ♂, Tadzhikistan, Sikat, south slope of Petra I Range, 13.vi.1963 (*Soboleva*) (paratype of *Diplocolenus alaicus* Emeljanov) (BMNH).

*Diplocolenus (Erdianus) logvinenkoae* Emeljanov

(Text-figs 13, 32, 52, 67, 96 and 97)

*Diplocolenus logvinenkoae* Emeljanov, 1964 : 432. Syntypes [sex and number not stated], U.S.S.R.: Kazakhstan (ZI, Leningrad, and BMNH) [1 ♂ examined].

Length: ♂ 4.0 mm.

Colour as in *alaicus*.

Male genitalia with pygophore as wide as long, terminating posteroventrally in a short robust ventrally directed process, with a large membranous expansion on dorsal margin; Xth segment with sides strongly convex, exceeding apex of pygophore, not sclerotized ventrally; subgenital plates with finger-like apex approximately as long as wide with several setae on ventral surface, lateral row of setae multiseriate, plates not reaching apex of pygophore; styles with apical process robust and triangulate, lateral lobe small; connective as long as styles, arms parallel distally and fused over short distance of length; aedeagus with shaft elongate, directed dorsally with apical one fourth turned posteriorly, terminating in a pair of short slender anteriorly directed divergent processes, basal apodeme very short with dorsolateral corners strongly produced dorsolaterally.

DISTRIBUTION. Kazakhstan, U.S.S.R.

MATERIAL STUDIED.

U.S.S.R.: 1 ♂, Kazakhstan, Akmolinsk Province, Kokshetau, nr. Tersakkan (*Emeljanov*) (syntype of *Diplocolenus logvinenkoae* Emeljanov, labelled as 'paratype') (BMNH).

*Diplocolenus (Erdianus) orientalis* (Ribaut)

(Text-figs 14, 33, 53, 74, 98 and 99)

*Deltocephalus orientalis* Ribaut, 1936 : 261. Holotype ♂, FRANCE: Pyrénées-Orientales, Puyvalador (RC, Toulouse) [not examined].

Length: ♂ 4.00-4.10 mm (mean 4.05 mm); ♀ 5.00 mm.

Colour as in *alaicus*.

Male genitalia with pygophore as long as wide and terminating in a short slender ventro-posteriorly directed process, without membranous expansion on dorsal margin; Xth segment

with sides strongly divergent towards base, not reaching apex of pygophore, not sclerotized ventrally; subgenital plates with finger-like apex nearly twice as long as wide and with a few setae ventrally, lateral row of setae multiseriate, plates reaching apex of pygophore; styles with apical process slender and curving posterolaterally, lateral lobe well developed; connective shorter than styles, arms convergent distally and fused over short distance of length; aedeagus with shaft elongate, directed dorsally with apical one fourth turned posteriorly and terminating in a pair of short triangulate anteriorly directed processes, basal apodeme very short with dorsolateral corners strongly produced dorsolaterally.

DISTRIBUTION. Southern France.

#### MATERIAL STUDIED.

FRANCE: 1 ♂, Ariège, Saint Béat (*Ribaut*) (paratype of *Deltocephalus orientalis* Ribaut) (BMNH); 1 ♂, Ariège, Quérigut, 19.vii.1936 (*Ribaut*) (WW, Hamburg); 1 ♀, Pyrénées Orientales, Canigou, 2.viii.1957 (*Gravostein*) (WW, Hamburg).

This species was originally included in *Diplocolenus* by Ribaut (1946 : 85).

### *Diplocolenus (Erdianus) limbatellus* (Zetterstedt)

(Text-figs 15, 34, 54, 77, 102 & 103)

*Cicada abdominalis limbatella* Zetterstedt, 1828 : 522. LECTOTYPE ♂, SWEDEN: Lapland, 27.vii.—(UZI, Lund), here designated [examined].

Length: ♂ 3.4–3.9 mm (mean 3.8 mm); ♀ 3.5–3.7 mm (mean 3.6 mm).

Colour pale green, with or without fuscous markings, apices of apical cells fuscous; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia with pygophore wider than long, terminating posteroventrally in a short robust posteriorly directed process, with a narrow membranous expansion on dorsal margin; Xth segment globular with sides strongly convex, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with finger-like apex short, approximately as long as wide and with a few setae on ventral surface, lateral row of setae uniseriate, plates not reaching apex of pygophore; styles with apical process slender, curving laterally, lateral lobe well developed; connective as long as styles, arms parallel distally and fused over short distance of length; aedeagus with shaft elongate, directed dorsally with apical third turned posteriorly, terminating in a pair of broad leaf-like and apically attenuated processes directed laterally and curving dorso-anteriorly, a pair of much smaller triangular processes laterally immediately basad of apical pair and directed laterally, basal apodeme very short with dorso-lateral corners strongly produced laterally.

DISTRIBUTION. Scandinavia and northern U.S.S.R.

#### MATERIAL STUDIED.

Lectotype ♂ and paralectotype ♂ of *Cicada abdominalis limbatella* Zetterstedt (UZI, Lund).

SWEDEN: 2 ♂, 1 ♀, L. Tjultrask, 16°5'E. 66°N., 29.viii.1962; 3 ♂, Lapland, south of Riksgransen below Satnjarastjarro, 900–1000 m, 19.vii.1957 (*Gardiner*); 1 ♀, Lapland, south of Riksgransen, slopes of Jarpa-Karpel, 900–1000 m, 21.vii.1957 (*Gardiner*); 2 ♂, Pite Lappm., Vuoggatjalme, 9.viii.1933 (*Ossiannilsson*); 1 ♀, Pite Lappm., Vuoggatjalme, 8.viii.1933 (*Ossiannilsson*). NORWAY: 2 ♂, 4 ♀, Ny Sulitjelma, 67°9'N. 16°8'E., 6.viii.1961; 3 ♀, Ny Sulitjelma, 67°9'N. 16°8'E.,



7.viii.1961; 1 ♂, 1 ♀, Jotunheimen Gjendesheim, 1000–1500 m, 7.vii.1966 (*Benson*); 5 ♂, 3 ♀, Kongsvold, Dovre, 7.vii.1933 (*Nordman*); 1 ♀, Rogaland, 11.vii.1940 (*Holgersen*). FINLAND: 2 ♀, Lapland, Enontekio, in birch zone below S.E. slopes of Tshuukisvaara, 15.viii.1957 (*Scott*); 3 ♀, Lapland, Enontekio, in birch zone below S.E. slopes of Tshuukisvaara, 15.viii.1957 (*Groves*). U.S.S.R.: 1 ♂, Urals, Lipin, 21–23.vii.1927 (*Flerov*); 1 ♂, Petsamo, Linnaniemi. All in BMNH.

The type-series of *Cicada abdominalis limbatella* Zetterstedt, deposited in the UZI, Lund, and consisting of one male labelled '85' and 'var. b. limbatella. ♂.' and another male without labels, was examined. The male with the above labels is here designated as lectotype and the other as paralectotype.

This species was originally included in *Diplocolenus* by Ribaut (1946 : 85).

### *Diplocolenus (Erdianus) sichotanus* Anufriev

(Text-figs 106 & 107)

*Diplocolenus sichotanus* Anufriev, 1971 : 115. Holotype ♂, U.S.S.R.: Primorski Krai, Sikhote-Alin Reserve, upper reaches of Sakhalin stream, 25.vi.1967 (*Anufriev*) (ZI, Leningrad) [not examined].

Length: ♂ 4·10–4·20 mm (mean 4·15 mm); ♀ 3·60–4·08 mm (mean 3·84 mm).

Colour as in *limbatellus*.

Male genitalia as in *limbatellus* but with shaft of aedeagus relatively wider, apical processes larger and directed more laterad and with subapical processes larger and directed more ventrad.

DISTRIBUTION. Mongolia and Primorsk Territory, U.S.S.R.

#### MATERIAL STUDIED.

U.S.S.R.: 2 ♂, 1 ♀, Primorsk Territory, Sikhote-Alin Reserve, 7.vii.1967 (*Anufriev*) (paratypes of *Diplocolenus sichotanus* Anufriev) (BMNH). MONGOLIA: 1 ♂, 1 ♀, Bulgan, 6.viii.1965 (*Dlabola*) (GAA, Gorky).

### *Diplocolenus (Erdianus) kyrilli* Emeljanov

(Text-figs 104 & 105)

*Diplocolenus kyrilli* Emeljanov, 1966 : 123. Holotype ♂, U.S.S.R.: Kazakhstan, Saur Mountains, Alatau Gorge, 10.vii.1962 (*Emeljanov*) (ZI, Leningrad) [not examined].

Length: ♂ 3·7 mm.

Colour as in *limbatellus*.

Male genitalia as in *limbatellus* but with apical processes of the aedeagus less divergent and subapical processes relatively larger and directed more dorsad.

DISTRIBUTION. Altayskaya Province and Kazakhskaya Republic, U.S.S.R.

#### MATERIAL STUDIED.

U.S.S.R.: 1 ♂, Altay, Ust-Kan, 8.vii.1923 (*Vinogradov*) (paratype of *Diplocolenus kyrilli* Emeljanov) (BMNH).

The close similarity between *limbatellus*, *sichotanus* and *kyrilli* suggests that they may be the same species although longer series from throughout their respective

ranges are required for confirmation. *D. limbatellus* is a northern species whilst both *sichotanus* and *kyrilli* occur in the southern and more eastern parts of the Palaearctic.

***Diplocolenus (Erdianus) kaszabi* Dlabola**

(Text-figs 108 & 109)

*Diplocolenus kaszabi* Dlabola, 1965 : 122. Holotype ♂, MONGOLIA: Central Aimak, Ulan-Baator, Zaisan [not 'Nucht' as stated by Dlabola] im Bogdo ul, 1420-1500 m, 18.vi.1963 [not '1500 m' and '16.vi.1963' as stated by Dlabola] (*Kaszab*) (TM, Budapest) [examined].

Length: ♂ 3.60-3.94 mm (mean 3.77 mm).

Male genitalia as in *limbatellus* but with apical processes of aedeagus broadly cleft apically.

DISTRIBUTION. Mongolia.

MATERIAL STUDIED.

Holotype ♂ of *Diplocolenus kaszabi* Dlabola (TM, Budapest).

1 ♂ paratype of *Diplocolenus kaszabi* Dlabola, same data as holotype (TM, Budapest); 1 ♂ paratype of *Diplocolenus kaszabi* Dlabola, same data as holotype (NM, Prague).

***Diplocolenus (Erdianus) bensoni* (China)**

(Text-figs 110 & 111)

*Euscelis bensoni* China, 1933 : 107. LECTOTYPE ♂, GREAT BRITAIN: Scotland, Perthshire, Ben Lawers, 2000', -vi.1932 (*Benson*) (BMNH), here designated [examined].

*Deltocephalus obenbergeri* Dlabola, 1945 : 173. Holotype ♂, CZECHOSLOVAKIA: Bohemia, Krkonoše, Kotelné jámy, 10.vii.1922 (*Novický & Ogloblin*) (NM, Prague) [examined].

*Deltocephalus bohemicus* Lang, 1947 : 93. ♂ ♀ syntypes [number not stated], CZECHOSLOVAKIA: Bohemia, Sumava Mountains, Boubin, 1362 m, 19.vii.1937, Modrava, 21.vii.1937 (*Lang*) (NM, Prague) [not examined].

Length: ♂ 3.50-3.60 mm (mean 3.55 mm); ♀ 4.04-4.32 mm (mean 4.18 mm).

Colour pale green, fore wings, and sometimes vertex, pronotum and scutellum, usually densely speckled with brown; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia as in *limbatellus* but with shaft of aedeagus more elongate and apical processes slender.

DISTRIBUTION. Great Britain, Norway, Netherlands, France, Poland and Czechoslovakia.

MATERIAL STUDIED.

Lectotype ♂ of *Euscelis bensoni* China (BMNH); holotype ♂ of *Deltocephalus obenbergeri* Dlabola (NM, Prague).

GREAT BRITAIN: 4 ♂, 3 ♀, Scotland, Perthshire, Ben Lawers, 1500', 27.vi.1936 (BMNH); 1 ♂, England, Cumberland, Hard Knott Pass, 1290', 19.vi.1936 (*Smart*) (BMNH). NORWAY: 1 ♂, 1 ♀, Rogaland, Suldal, 7-9.vii.1941 (*Holgensen*) (BMNH). POLAND: 2 ♀, Gory Jzerskie, Podmokta, hala, 12.vii.1958 (*Trojan*) (IZPAN, Warsaw); 1 ♂, Gory Jzerskie, Lwowek Slaski, Stog Jzerski, 10.vii.1958 (*Trojan*)

(IZPAN, Warsaw); 1 ♂, Gory Jzerskie, 17.vii.1960 (*Bankowska*) (IZPAN, Warsaw). CZECHOSLOVAKIA: 1 ♂, Bohemia, Sumava, Modrava, Kočmíd, -.viii.1951 (NM, Prague); 2 ♂, 3 ♀, Bohemia, Sněžka, 1600 m, 2.viii.1965 (*Dlabola*) (NM, Prague); 1 ♀, Bohemia, Krkonoše, Kotelné jámy, 10.vii.1922 (*Novicky & Ogloblin*) (paratype of *Deltocephalus obenbergeri* Dlabola) (NM, Prague).

Of the original two specimens in the type-series of *Euscelis bensoni*, only one male, labelled 'Perthshire Ben Lawers 2,000' vi. 1932 R. B. Benson' and 'Euscelis bensoni China TYPE det. W. E. China 1932', is present in the BMNH. This specimen is here designated as lectotype.

*Euscelis bensoni* was first transferred to *Diplocolenus* by China (1950 : 245). *Deltocephalus obenbergeri* was transferred to *Diplocolenus* by Ribaut (1952 : 282) who in the same work (p. 287) listed *Deltocephalus bohemicus* as its synonym for the first time. *D. obenbergeri* was synonymised with *bensoni* by LeQuesne (1969 : 86).

This species, with its slender aedeagal processes, appears to be the primitive form of the *limbatellus* line.

### *Diplocolenus (Erdianus) convenarum* Ribaut

(Text-figs 16, 35, 55, 76, 100 & 101)

*Deltocephalus montanus* Ribaut, 1936 : 259. Holotype ♂, FRANCE: Hautes-Pyrénées, Lourdevielle (depository unknown) [not examined]. [Primary homonym of *Deltocephalus montanus* Distant, 1908 : 384.]

*Diplocolenus convenarum* Ribaut, 1946 : 85. [Replacement name for *Deltocephalus montanus* Ribaut, 1936.]

Length: ♂ 3.8 mm.

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia with pygophore as wide as long, terminating posteroventrally in a short robust ventrally directed process, without membranous expansion on dorsal margin; Xth segment with sides strongly divergent towards base, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with finger-like apex nearly twice as long as wide, without setae, lateral row of setae uniseriate, plates reaching apex of pygophore; styles with apical process slender and curving laterally, lateral lobe well developed; connective shorter than styles, arms parallel distally and fused for only short distance of length; aedeagus with shaft elongate, straight, directed dorsoposteriorly and terminating in a pair of short dorsally directed processes, basal apodeme short with dorsolateral corners strongly produced dorso-laterally.

DISTRIBUTION. France.

MATERIAL STUDIED.

FRANCE: 1 ♂, Ariège, Saint Béat (*Ribaut*) (paratype of *Deltocephalus montanus* Ribaut) (BMNH).

This species was originally included in *Diplocolenus* by Ribaut (1946 : 85).

*Diplocolenus (Erdianus) quadrivirgatus* (Horvath)

(Text-figs 17, 36, 56, 75, 112 &amp; 113)

*Deltocephalus quadrivirgatus* Horvath, 1884 : 319. LECTOTYPE ♂, HUNGARY: Mármaros, Pop Ivan, 20.vii.1883 (TM, Budapest), here designated [examined].

[*Deltocephalus nigricans* Kirschbaum; Nast, 1938 : 163. Misidentification.]

*Deltocephalus nasti* Wagner, 1939 : 168. ♂ ♀ syntypes, U.S.S.R.: Carpathians, 3 ♀, mountain ridge between Mt. Gorgan & Mt. Siwula, 1400 m, 15.vii.1937 (*Tarwid*), 1 ♀, slopes of Mt. Siwula & Lopuszna, 1400-1450 m, 15.vii.1937 (*Tarwid*), 1 ♂, 3 ♀, meadows on the slopes of Grofe-Berges, 1400-1550 m, 24.vii.1937 (*Tarwid*), 1 ♀, meadow below summit of Mt. Wysoka, 1680 m, 3.viii.1937 (*Tarwid*) (destroyed<sup>5</sup>). [Proposed as 'nom. nov.' for *Deltocephalus nigricans* Kirschbaum sensu Nast, 1938 : 163. **Syn. n.**

Length: ♂ 3.60-4.18 mm (mean 3.89 mm); ♀ 4.92 mm.

Colour pale green with transverse band across vertex, pronotum, scutellum, apex and medial areas of fore wings, face, venter and legs dark brown, latter sometimes pale and poorly developed.

Male genitalia with pygophore as wide as long, terminating posteroventrally in a short robust ventrally directed process, a narrow membranous expansion from dorsal margin; Xth segment with sides convex, not reaching apex of pygophore, sclerotized ventrally on posterior margin; subgenital plates with finger-like apex approximately  $1\frac{1}{2}$  times as long as its basal width with a uniseriate row of setae over its ventral surface, lateral row of setae multiseriate, plates slightly exceeding apex of pygophore; styles with apical process slender, curving laterally, lateral lobe well developed; connective shorter than styles, arms parallel distally and fused for only very short part of length; aedeagus with shaft elongate, directed dorsally with distal third turned posteriorly, terminating in two pairs of slender processes of approximately equal length, one pair directed dorsally and the other directed ventrally, basal apodeme short with dorsolateral corners produced dorsolaterally.

DISTRIBUTION. S.E. Europe.

## MATERIAL STUDIED.

Lectotype ♂ and paralectotypes of *Deltocephalus quadrivirgatus* Horvath (TM, Budapest).

HUNGARY: 1 ♂, 1 ♀, Gyulafalva, Górhavas, Aigner (TM, Budapest). BULGARIA: 1 ♂, 1 ♀, Rila, 2000 m, 12.viii.1959 (*Burakowski*) (BMNH). U.S.S.R.: 1 ♂, Ukraine, Transcarpathian Province, Krasnaya, 2.vii.1961 (*Loginova*) (BMNH).

The type-series of *Deltocephalus quadrivirgatus* Horvath, deposited in the TM, Budapest, consists of a male labelled 'Mármaros Pop Ivan 20.7.83' and a female and one other specimen without an abdomen with the same data. All three specimens were examined and the male is here designated as lectotype and the other two specimens as paralectotypes.

This species was described and figured by Nast (1938 : 163, fig. 2) as *Deltocephalus nigricans* Kirschbaum. Wagner (1939 : 168), after studying Kirschbaum's types, found Nast's species to be distinct from *D. nigricans* Kirschbaum and renamed it *Deltocephalus nasti*. Ribaut (1946 : 85) listed it as one of the originally included species in *Diplocolenus*.

It is the most primitive member of the *quadrivirgatus/quadricornis/nigricans/penthopitta* group and still retains the slender form of the aedeagus and apical processes.

<sup>5</sup> Destroyed by fire in the Zoological Museum, Warsaw, in 1944 (Dr I. Dworakowska, personal communication).

***Diplocolenus (Erdianus) quadricornis* Ribaut**

*Diplocolenus (Sabelanus) quadricornis* Ribaut, 1959 : 402. Holotype ♂, FRANCE: Alpes-Maritimes, Esteng, -vii.1956 (*Tempère*) (? SC, Strasbourg) [not examined].

This species, which is well illustrated by Ribaut (1959 : 401, figs 8-11), is closely related to *quadrivirgatus*, *penthopitta* and *nigricans*. It resembles all three species in the shape of the pygophore and has a long finger-like apex to the subgenital plate as in *penthopitta* and *nigricans*. The apical process of the style is similar to that of *quadrivirgatus* and *nigricans*. The aedeagus is intermediate in shape between *quadrivirgatus* and *nigricans* with the shaft short straight and robust and terminating in two pairs of stout processes, a short dorsal pair and a slightly longer ventral pair.

DISTRIBUTION. S.W. France.

MATERIAL STUDIED. No specimens were available for the present study.

This species still retains the distinct apical processes to the aedeagus seen in *quadrivirgatus* but has undergone a general shortening of the aedeagus and an extension of the apical process on the subgenital plate.

***Diplocolenus (Erdianus) nigricans* (Kirschbaum)**

(Text-figs 19, 38, 58, 72, 116, 117 & 118)

*Jassus (Deltocephalus) nigricans* Kirschbaum, 1868 : 129. ♂ ♀ syntypes [number not stated], SWITZERLAND: Bernina (*Heyden*) (? NM, Wiesbaden) [not examined].

Length: ♂ 4.1 mm; ♀ 4.7 mm.

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia with pygophore slightly longer than wide, terminating posteroventrally in a short robust posteroventrally directed process, with a small membranous expansion from dorsal margin; Xth segment with sides convex, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with finger-like apex twice as long as wide with a row of setae over apical half of ventral surface, lateral row of setae uniseriate, plates reaching to apex of pygophore; styles with apical process slender and curving laterally, lateral lobe well developed; connective slightly longer than styles, arms parallel distally and fused over large part of length; aedeagus with shaft short, directed dorsally with distal third turned dorsoposteriorly and expanded at apex into broad umbrella-like plate perpendicular to shaft. its anterior margin deeply and narrowly incised.

DISTRIBUTION. Southern Europe.

MATERIAL STUDIED.

AUSTRIA: 1 ♂, 1 ♀, Trentino, Yal Sugana, Panarotta (LC, Raisio).

This species was originally included in *Diplocolenus* by Ribaut (1946 : 85). It is one of the most specialized forms of the *quadrivirgatus/quadricornis/nigricans/penthopitta* line, in which the apical processes of the aedeagus have become fused to form a terminal plate.

*Diplocolenus (Erdianus) penthopitta* (Walker) nom. rev.

(Text-figs 18, 37, 57, 73, 114 &amp; 115)

*Bythoscopus* ? *Penthopitta* Walker, 1851 : 864. ♀ type(s) [number not stated], FRANCE: (*Perris*) (depository unknown) [not examined].

*Acocephalus sudeticus* Kolenati, 1860 : 390. NEOTYPE ♂, CZECHOSLOVAKIA: Moravia, Hr. Jeseník-Praděd, 21.ix.1970 (*Lauterer*) (MM, Brno), here designated [examined]. **Syn. n.**

Length: ♂ 3.82–4.30 mm (mean 4.02 mm); ♀ 4.42–4.62 mm (mean 4.50 mm).

Colour uniformly dark brown or with vertex, pronotum and fore wings pale green or cream variably marked with dark brown.

Male genitalia with pygophore as long as wide, terminating posteriorly in a short robust ventrally directed process, with a narrow membranous expansion from dorsal margin; Xth segment with sides convex, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with finger-like apex twice as long as wide with cluster of setae on apical half of ventral surface, lateral row of setae uniseriate, plates exceeding apex of pygophore; styles with apical process short, robust, curving laterally, lateral lobe well developed; connective longer than styles, arms parallel distally and fused over short distance of length; aedeagus with shaft short and broadly lamellate with lateral margins curving ventrally, terminating in a pair of short ventrally directed processes, basal apodeme short and broad.

DISTRIBUTION. E. Europe.

MATERIAL STUDIED.

Neotype ♂ of *Acocephalus sudeticus* Kolenati (MM, Brno).

CZECHOSLOVAKIA: 2 ♂, 6 ♀, Moravia, Hr. Jeseník, Petrovy kameny, 19.ix.1970 (*Lauterer*) (MM, Brno); 3 ♂, 8 ♀, Moravia, Hr. Jeseník-Vel. Kotel, 20.ix.1970 (*Lauterer*) (MM, Brno); 4 ♂, Moravia, Hr. Jeseník-Praděd, 21.ix.1970 (*Lauterer*) (MM, Brno); 1 ♂, Bohemia, Velká, Deštná, 1114 m, Orlické h., 6.viii.1945 (*Polacek*) (NM, Prague); 1 ♂, 1 ♀ Moravia, Jeseníky, –.ix.1946 (*Dlabola*) (BMNH); 1 ♂, Sudeten (*Hedwig*) (WW, Hamburg). AUSTRIA: 1 ♀, Schneeberg, 19.vii.1941 (*Hedwig*) (WW, Hamburg). POLAND: 1 ♂, 1 ♀, Klodzko, 2.viii.1958 (*Trojan*) (IZPAN, Warsaw).

The Kolenati Collection, containing the type-series of *Acocephalus sudeticus*, could not be located in either Czechoslovakia<sup>6</sup> or the Naturhistorisches Museum, Vienna,<sup>7</sup> and is presumed to have been destroyed. A topotype male labelled 'Mor. bor. 21.9.1970 Hr. Jeseník-Praděd lgt. P. Lauterer 49/70' is here designated as neotype and is deposited in the MM, Brno.

This species was first described by Amyot (1847 : 219) with the non-binomial, and hence unavailable, name *Penthopitta*. The name was subsequently used binomially by Walker (1851 : 864) who placed it in the genus *Bythoscopus*. Although Walker gave no description, he referred to Amyot's work and thereby satisfied Articles 11, 12 and 16 of the *International Code of Zoological Nomenclature*. Walker's work has gone unnoticed by subsequent workers, the name *penthopitta* having been attributed to Fieber (1869 : 221) and therefore erroneously considered, since Lang (1947 : 20), as a junior synonym of *sudeticus* Kolenati, 1860.

<sup>6</sup> Dr J. Stehlik, personal communication.

<sup>7</sup> Dr A. Kaltenbach, personal communication.

This species was originally included in *Diplocoenus* by Ribaut (1946 : 85). It is the most specialized form of the *quadrivirgatus/quadricornis/nigricans/penthopitta* line in which the anterior processes of the aedeagus have been lost and the atrium has been extended ventrally. It is further specialized by the reduction of the apical process of the style.

*Diplocoenus (Verdanus) evansi* (Ashmead)

(Text-figs 20, 39, 59, 78, 119 & 120)

*Deltocephalus evansi* Ashmead, 1904 : 132. LECTOTYPE ♂, ALASKA: Kussiloff, -.vii.1898 (Evans) (USNM, Washington), here designated [examined].

*Diplocoenus dauricus* Emeljanov, 1966 : 123. Holotype ♂, U.S.S.R.: Chitinskaya Province, R. Talanguy, south of Zhuravlev, 4.viii.1963 (Emeljanov) (ZI, Leningrad) [not examined].

**Syn. n.**

Length: ♂ 3.40–4.00 mm (mean 3.70 mm); ♀ 3.70–4.20 mm (mean 3.90 mm).

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia with pygophore as long as wide, terminating posteroventrally in a short robust ventrally directed process, a large semimembranous expansion from dorsal margin; Xth segment with sides strongly convex, extending to apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with finger-like apex slightly longer than wide, without setae on ventral surface, lateral row of setae uniseriate, plates extending to apex of pygophore; styles with apical process slender curving laterally, lateral lobe well developed; connective approximately half length of styles, arms widely separated and divergent distally to near apex and then abruptly angled to midline and fused; aedeagus with shaft elongate, directed dorsally with apex turned posteriorly and terminating in a pair of long slender processes directed laterally for approximately one third length and then abruptly ventrolaterally, basal apodeme long and narrow with dorsolateral corners produced dorsally.

**DISTRIBUTION.** Northern U.S.A., Canada, Alaska and eastern U.S.S.R.

**MATERIAL STUDIED.**

Lectotype ♂ of *Deltocephalus evansi* Ashmead (USNM, Washington).

U.S.A.: 1 ♂, 2 ♀, Colorado, Waldren, Jackson Co., 9.viii.1964 (Knowlton); 1 ♀, Colorado, Steamboat Springs, 9.viii.1964 (Knowlton); 1 ♀, Colorado, Lindland, 12.viii.1964 (Knowlton); 1 ♂, Colorado, Gould, 14.viii.1966 (Knowlton); 1 ♀, Montana, Bozeman, 19.vii.1920 (Downes). CANADA: 1 ♂, 7 ♀, Ontario, Black Sturg. Lake, 1–15.viii.1956 (Lindberg); 1 ♀, B.C., Chilcotin, 9.vi.1929 (Downes); 1 ♂, Alberta, McMurray, 7.viii.1953 (Ball); 2 ♂, 10 ♀, Labrador, Kinriakak Point, L. Melville, 20–21.viii.1958, B.S.E.S. Expedition; 3 ♂, 17 ♀, Labrador, Hopedale, 13.viii.1935, 8 ♂, 13 ♀, 16.vii.1935, 1 ♂, 14 ♀, 19.viii.1935, 12 ♀, 12.viii.1935, 1 ♀, 14.viii.1936, 1 ♀, 7.viii.1936 (Perrett). U.S.S.R.: 1 ♂, Kamchatka, River Kamchatka, Klyuchevskaya, 15.vi.1909 (Derjabin); 1 ♂, Transbaikalia, Tyrgituy, S. of Chita, 22.vi.1914 (Gavrilyuk). All in BMNH.

According to Ashmead (1904 : 133) the type of *Deltocephalus evansi*, with the data 'Kusilof, July, 1898 (W. H. Evans)', bears the catalogue number 6869 in the USNM, Washington. He also refers to additional specimens from Metlakatla

collected on 4th July. Only a male and a female, each with the data 'Kussiloff, Alaska, July 1898, W. H. Evans' but without a catalogue number, are present in the USNM<sup>8</sup>. The male, which was examined, is here designated as lectotype.

Emeljanov (1966: 123) considers *dauricus* to differ from *evansi* by having longer apical processes on the aedeagus with the part basad of the bend being shorter than the distal part rather than the reverse as in *evansi*. An examination of *evansi* specimens from throughout its range, however, shows Emeljanov's interpretation of the species to be incorrect and that both species are the same.

*Deltocephalus evansi* was made the type-species of *Verdanus* by Oman (1949: 165) and transferred to the present genus for the first time by Ribaut (1952: 285) who considered *Verdanus* as a subgenus of *Diplocolenus*. Apart from the more primitive *configuratus* it is the only species of the genus which has dispersed into the New World although unlike *configuratus* it is not endemic.

### *Diplocolenus (Verdanus) abdominalis* (Fabricius)

(Text-figs 5, 6, 21, 40, 60, 79, 121 & 122)

*Cicada bicolor* Fabricius, 1794: 40. LECTOTYPE ♂, DENMARK: (UZM, Copenhagen), here designated [examined]. [Primary homonym of *Cicada bicolor* Olivier, 1790: 743.]

*Cercopis abdominalis* Fabricius, 1803: 98. [Replacement name for *Cicada bicolor* Fabricius, 1794.]

*Cicada balteata* Zetterstedt, 1840: 290. LECTOTYPE ♀, SWEDEN: Lapland, 30.vi.- (Zetterstedt) (UZI, Lund), here designated [examined].

*Aphrodes juvenca* Hardy, 1850: 425. Holotype [sex not stated], GREAT BRITAIN: Scotland, Berwickshire (depository unknown).

Length: ♂ 3.8-4.4 mm (mean 4.2 mm); ♀ 3.7-4.2 mm (mean 4.0 mm).

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia with pygophore longer than wide, without posterior process, with a broad semi-membranous expansion from dorsal margin; Xth segment with sides strongly convex, not reaching apex of pygophore, not sclerotized ventrally; subgenital plates with finger-like apex approximately as long as wide, without setae on ventral surface, lateral row of setae uniseriate, plates not reaching apex of pygophore; styles with apical process slender and curving laterally, lateral lobe well developed; connective approximately two thirds length of styles, arms widely separated and divergent distally to near apex and then abruptly angled to midline where fused; aedeagus with shaft elongate, directed dorsally with apex turned posteriorly and terminating in a pair of long slender processes directed laterally and then bifurcating into branches of approximately equal length, one directed ventrolaterally and the other anterodorsally, basal apodeme long and narrow with dorsolateral corners produced dorsally.

DISTRIBUTION. Great Britain, Europe, Scandinavia, N. Africa, U.S.S.R. and Mongolia.

MATERIAL STUDIED.

Lectotype ♂ of *Cicada bicolor* Fabricius (UZM, Copenhagen); lectotype ♀ of *Cicada balteata* Zetterstedt (UZI, Lund).

<sup>8</sup> Dr J. P. Kramer, personal communication.



AUSTRIA: 1 ♂, 2 ♀, Hochschwab, 2000 m; 1 ♀, Tyrol, Kitzbuhel, 18-29.viii.1962 (Hayes); 1 ♂, 1 ♀, Tyrol, Landeck, -.vi.1957 (Day & Ward); 1 ♂, 3 ♀, Hainfeld (Eger). FRANCE: 1 ♀, Vienne, St. Benoit. ITALY: 1 ♀, Merano, 23.vii.1957 (Ward). NORWAY: 1 ♂, 2 ♀, Rogaland, Suldal, 7-9.vii.1941 (Holgersen). POLAND: 2 ♂, Zakopane, Tatra Mts., 2,300', 27.vi.1932 (Aubertin & Trewavas). All in BMNH.

In the original description of *Cicada balteata* there was no indication of the number of specimens in the type-series although only females were studied. There is a single female type of this species in the UZI, Lund, which was examined and is here designated as lectotype.

There is only one specimen in the type-series of *Cicada bicolor* in the UZM, Copenhagen, which was examined and is here designated as lectotype.

*Cicada balteata* was first synonymized with *abdominalis* by Thomson (1869 : 66) and *Aphrodes juvenca* synonymized with *abdominalis* and *balteata* by Douglas & Scott (1876 : 89). The species was originally included in *Diplocolenus* by Ribaut (1946 : 85). It is the only species amongst the more specialized members of the genus that has become widely distributed throughout the Palaearctic Region, the majority being restricted to various parts of Europe or the south-west U.S.S.R.

### *Diplocolenus (Verdanus) temperei* Ribaut

*Diplocolenus temperei* Ribaut, 1959 : 402. Holotype ♂, FRANCE: Cantal, Le Lioran, 1.vi.1955 (*Tempère*) (? SC, Strasbourg) [not examined].

This species, which is well illustrated by Ribaut (1959 : 401, figs 5-7), is closely related to *abdominalis* but differs in having the two branches of each apical process of the aedeagus in an approximately straight line with each other rather than at right angles.

DISTRIBUTION. S.E. France.

MATERIAL STUDIED. No specimens were available for the present study.

### *Diplocolenus (Verdanus) laetitia* Servadei

(Text-figs 123 & 124)

*Diplocolenus laetitia* Servadei, 1960 : 330. Holotype [sex not stated], ITALY: Calabria (IEA, Padua) [not examined].

Length: ♂ 4.46 mm.

Colour as in *abdominalis*.

Male genitalia as in *abdominalis* but with apical processes of aedeagus closer together, with dorsal branch much shorter than ventral, distal half of shaft of aedeagus thicker than basal half and with apical process of styles directed more laterad at apex.

DISTRIBUTION. Southern Italy.

MATERIAL STUDIED.

ITALY: 1 ♂, Calabria, Lake Arvo, 31.v.1959 (Servadei) (LC, Raisio).

This species is closely related to *abdominalis*.

***Diplocolenus (Verdanus) rustavelicus* Logvinenko**

*Diplocolenus rustavelicus* Logvinenko, 1971 : 591. ♂ ♀, syntypes, U.S.S.R.: Georgia, Abastumani, Zekarskii Pass, 2000 m, 30.vi.1967-1.vii.1967 (IZ, Kiev) [not examined].

This species, which is illustrated by Logvinenko (1971 : 591, fig. 2), is similar to *laetitiae* in having the dorsal branch of the aedeagal processes much shorter than the ventral branch. It differs, however, in having the shaft of the aedeagus of uniform width except for a slight enlargement on each side near midlength.

DISTRIBUTION. Caucasus, U.S.S.R.

MATERIAL STUDIED. No specimens were available for the present study.

This species is very similar to *laetitiae* and may be the same species.

***Diplocolenus (Verdanus) monticola* Linnavuori stat. n.**

(Text-figs 125 & 126)

*Diplocolenus abdominalis monticola* Linnavuori, 1958 : 303. Holotype ♂, ITALY: Umbria, Mt. Sibillini, Pian Perduto, -vii.1954 (*Ruffo*) (LC, Raisio) [examined].

Length: ♂ 4.5 mm.

Colour as in *abdominalis*.

Male genitalia as in *abdominalis* but with apical processes of aedeagus much shorter and more robust and with shaft curving posteriorly from midlength.

DISTRIBUTION. Central Italy.

MATERIAL STUDIED.

Holotype ♂ of *Diplocolenus abdominalis monticola* Linnavuori (LC, Raisio).

***Diplocolenus (Verdanus) exsiliatus* Emeljanov**

(Text-figs 22, 41, 61, 80, 127 & 128)

*Diplocolenus exsiliatus* Emeljanov, 1966 : 123. Holotype ♂, U.S.S.R.: Yakutia, Verkhoyansk, -vi-vii.1903 (*Rozhnovskiy*) (ZI, Leningrad) [not examined].

Length: ♂ 4.2 mm.

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous marked with dark brown.

Male genitalia with pygophore longer than wide, without posterior process, with broad semi-membranous expansion from dorsal margin; Xth segment with sides strongly convex, not reaching apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with finger-like apex slightly longer than wide with a few setae on ventral surface, lateral row of setae uniseriate, plates not reaching apex of pygophore; styles with apical process slender and curving laterally, lateral lobe well developed; connective half length of styles, arms widely separated and divergent distally to near apex and then abruptly angled to midline where fused; aedeagus with shaft long and slender, directed dorsally to near midlength and then curving gradually posteriorly and terminating in a pair of small laterally directed leaf-like processes, basal apodeme long and narrow with dorsolateral corners produced dorsally.

DISTRIBUTION. Yakutskaya Republic, U.S.S.R.

MATERIAL STUDIED.

U.S.S.R.: 1 ♂, Yakutia, Verkhoyansk, -vi-vii.1903 (*Rozhnovskiy*) (paratype of *Diplocolenus exsiliatus* Emeljanov) (BMNH).

***Diplocolenus (Verdanus) caucasicus* Emeljanov**

*Diplocolenus caucasicus* Emeljanov, 1962 : 180. Holotype ♂, U.S.S.R.: Caucasus, Arkhyz, Kafiragura, 22.vii-6.viii.1939 (*D'yakonov*) (ZI, Leningrad) [not examined].

This species, of which only the aedeagus is illustrated by Emeljanov (1962 : 179, figs 90-91), is similar to *exsiliatus* in having the apical processes of the aedeagus reduced but differs in having a sinuate dorsally directed shaft. Additional material may show this species to be the same as *exsiliatus*.

DISTRIBUTION. Caucasia, U.S.S.R.

MATERIAL STUDIED. No specimens were available for the present study.

***Diplocolenus (Verdanus) tianshanicus* Emeljanov**

(Text-figs 23, 42, 62, 81, 129 & 130)

*Diplocolenus tianshanicus* Emeljanov, 1966 : 122. Holotype ♂, U.S.S.R.: Kirgizia, Terskey-Alatau, R. Chon-Kyzyl-Su, 8.vii.1964 (*Vtorov*) (ZI, Leningrad) [not examined].

Length: ♂ 4.0 mm.

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous, marked with dark brown.

Male genitalia with pygophore as long as wide, terminating posteroventrally in a short ventrally directed process, a broad semi-membranous expansion from dorsal margin; Xth segment with sides strongly convex, reaching to apex of pygophore, sclerotized ventrally along posterior margin; subgenital plates with finger-like apex nearly twice as long as wide with a small group of setae on ventral surface, lateral row of setae uniseriate or biseriate, plates reaching to apex of pygophore; styles with apical process slender and curving laterally, lateral lobe well developed; connective approximately two-thirds length of styles, arms widely separated and divergent distally and then abruptly angled to midline where fused; aedeagus with shaft long and slender, directed dorsally to near apex and then curved abruptly posteriorly, terminating in a pair of very small lateral processes and a long slender ventrally directed medial process, basal apodeme long and narrow with dorsolateral corners produced dorsally.

DISTRIBUTION. Kirgizskaya Republic and Kazakhskaya Republic, U.S.S.R.

MATERIAL STUDIED.

U.S.S.R.: 1 ♂, Kirgizia, Terskey-Alatau, R. Chon-Kyzyl-Su, 8.vii.1964 (*Vtorov*) (paratype of *Diplocolenus tianshanicus* Emeljanov) (BMNH).

This species, which is unique within the genus in having an additional unpaired process at the apex of the aedeagus, is most closely related to *exsiliatus*.

*Diplocolenus (Verdanus) intermedius* Emeljanov

(Text-figs 24, 43, 63, 82, 131 &amp; 132)

*Diplocolenus intermedius* Emeljanov, 1964 : 432. Syntypes [sex and number not stated], U.S.S.R.: Caucasia (ZI, Leningrad, and BMNH) [1 ♂ examined].

Length: ♂ 4.10–4.20 mm (mean 4.15 mm).

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous, marked with dark brown.

Male genitalia with pygophore as long as wide, without posterior process, with broad semi-membranous expansion from dorsal margin; Xth segment with sides strongly convex, not reaching to apex of pygophore, not sclerotized ventrally; subgenital plates with finger-like apex slightly longer than wide, with short row of setae on ventral surface, lateral row of setae uniseriate, biseriate in part, plates not reaching apex of pygophore; styles with apical process slender and curving laterally, lateral lobe well developed; connective approximately two thirds length of styles, arms narrowly divergent to near apex and then abruptly angled to midline where fused; aedeagus with shaft elongate, directed dorsally with apex turned posteriorly and terminating in two pairs of ventrally directed processes, a short apical pair and a much longer subapical pair, basal apodeme long and narrow with dorsolateral corners produced dorsally.

DISTRIBUTION. West Caucasia, U.S.S.R.

## MATERIAL STUDIED.

U.S.S.R.: 1 ♂, R. Kichkipe, 2200–2600 m, Karachai, 15.vii.1935 (*Diakonov*) (syntype of *Diplocolenus intermedius* Emeljanov, labelled as 'paratype') (BMNH); 1 ♂, North Caucasus, Arkhyz, 6.viii.1939 (*Diakonov*) (paratype of *Diplocolenus caucasicus* Emeljanov) (BMNH).

*Diplocolenus (Verdanus) oseticus* Emeljanov

(Text-figs 44, 133 &amp; 134)

*Diplocolenus oseticus* Emeljanov, 1964 : 432. Syntypes [sex and number not stated], U.S.S.R.: Ossettia (ZI, Leningrad, and BMNH) [1 ♂ examined].

Length: ♂ 3.9 mm.

Colour as in *intermedius*.

Male genitalia as in *intermedius* but with apical pair of processes on aedeagus much shorter and with small projection posteroventrally on pygophore.

DISTRIBUTION. Ossettia, central Caucasia, U.S.S.R.

## MATERIAL STUDIED.

U.S.S.R.: 1 ♂, Caucasus, Voенно-Osetinsk Region, Turshevo, 19.vi.1913 (*Bartenyev*) (syntype of *Diplocolenus oseticus* Emeljanov, labelled as 'paratype') (BMNH).

The species *oseticus* and *intermedius* represent the early stage in the final evolutionary phase of the genus during which an additional pair of processes are developed at the apex of the aedeagus.

***Diplocolenus (Verdanus) ciscaucasicus* Emeljanov**

(Text-figs 25, 45, 64, 83, 135 &amp; 136)

*Diplocolenus ciscaucasicus* Emeljanov, 1964 : 432. Syntypes [sex and number not stated], U.S.S.R.: Ciscaucasia (ZI, Leningrad, and BMNH) [1 ♂ examined].*Diplocolenus daghestanicus* Emeljanov, 1964 : 432. Syntypes [sex and number not stated], U.S.S.R.: Daghestan (ZI, Leningrad, and BMNH) [1 ♂ examined]. **Syn. n.**

Length: ♂ 4.20–4.70 mm (mean 4.45 mm).

Colour pale green with apex of apical cells fuscous; face and venter dark brown; legs stramineous, marked with dark brown.

Male genitalia with pygophore slightly longer than wide, without posterior process, with a broad semi-membranous expansion from dorsal margin; Xth segment with sides strongly convex, not reaching apex of pygophore, not sclerotized ventrally; subgenital plates with finger-like apex approximately as long as wide and with small group of setae on ventral surface, lateral row of setae multiseriate, plates not reaching apex of pygophore; styles with apical process slender and curving laterally, lateral lobe well developed; connective approximately two thirds length of styles, arms widely separated and divergent distally to near apex and then abruptly angled to midline where fused; aedeagus with shaft elongate, directed dorsally with apex turned posteriorly and terminating in two pairs of ventrally directed processes, a triangulate posterior pair and a more slender lateral pair, those of each side fused together over their basal halves, basal apodeme long and narrow with dorsolateral corners produced dorsally.

DISTRIBUTION. Caucasus, U.S.S.R.

## MATERIAL STUDIED.

U.S.S.R.: 1 ♂, Caucasus, Nizhegorodskaya, Mayk. district, Kuba, 30.v.1911 (*Shaposhnikov*) (syntype of *Diplocolenus ciscaucasicus* Emeljanov, labelled as 'paratype') (BMNH); 1 ♂, Caucasus, Daghestan, Okyuz-tau, Gimrinsk Ridge, 7.vii.1940 (*Ryabov*) (syntype of *Diplocolenus daghestanicus* Emeljanov, labelled as 'paratype') (BMNH).

Both *ciscaucasicus* and *daghestanicus* are described on the same page, with *daghestanicus* having position priority. In the present synonymy, however, *ciscaucasicus* is chosen as the senior synonym as indicating a less restrictive distribution.

***Diplocolenus (Verdanus) admistus* Logvinenko***Diplocolenus admistus* Logvinenko, 1966 : 407. Holotype ♂, U.S.S.R.: Northwest Caucasus, Caucasian reservation, Sennaya clearing, 16.viii.1962 (*Logvinenko*) (IZ, Kiev) [examined].

Length: ♂ 4.20 mm.

Colour as in *ciscaucasicus*.

Male genitalia as in *ciscaucasicus* but with posterior or medial pair of processes on aedeagus fused over their basal half, the shaft of the aedeagus more S-shaped and with a small denticle on each lateral margin of basal apodeme.

DISTRIBUTION. N.W. Casasia, U.S.S.R.

## MATERIAL STUDIED.

Holotype ♂ of *Diplocolenus admistus* Logvinenko (IZ, Kiev).

This species is very similar to *ciscaucasicus* and may be the same species.

*Diplocolenus (Verdanus) melichari* Dlabola

(Text-figs 137 &amp; 138)

*Diplocolenus melichari* Dlabola, 1950 : 178. Holotype ♂, U.S.S.R. : Georgia, Tiflis, 21.viii.1912 (Zaitsev) (MM, Brno) [examined].

Length: ♂ 4.22 mm.

Colour as in *ciscaucasicus*.

Male genitalia as in *ciscaucasicus* but with apical processes of aedeagus more slender and independent of each other along their entire length and with lateral pair situated more dorsally on shaft and curving dorsolaterally at base rather than ventrolaterally.

DISTRIBUTION. Georgia Republic, U.S.S.R.

MATERIAL STUDIED.

Holotype ♂ of *Diplocolenus melichari* Dlabola (MM, Brno).

This species is the most highly specialized form within the genus.

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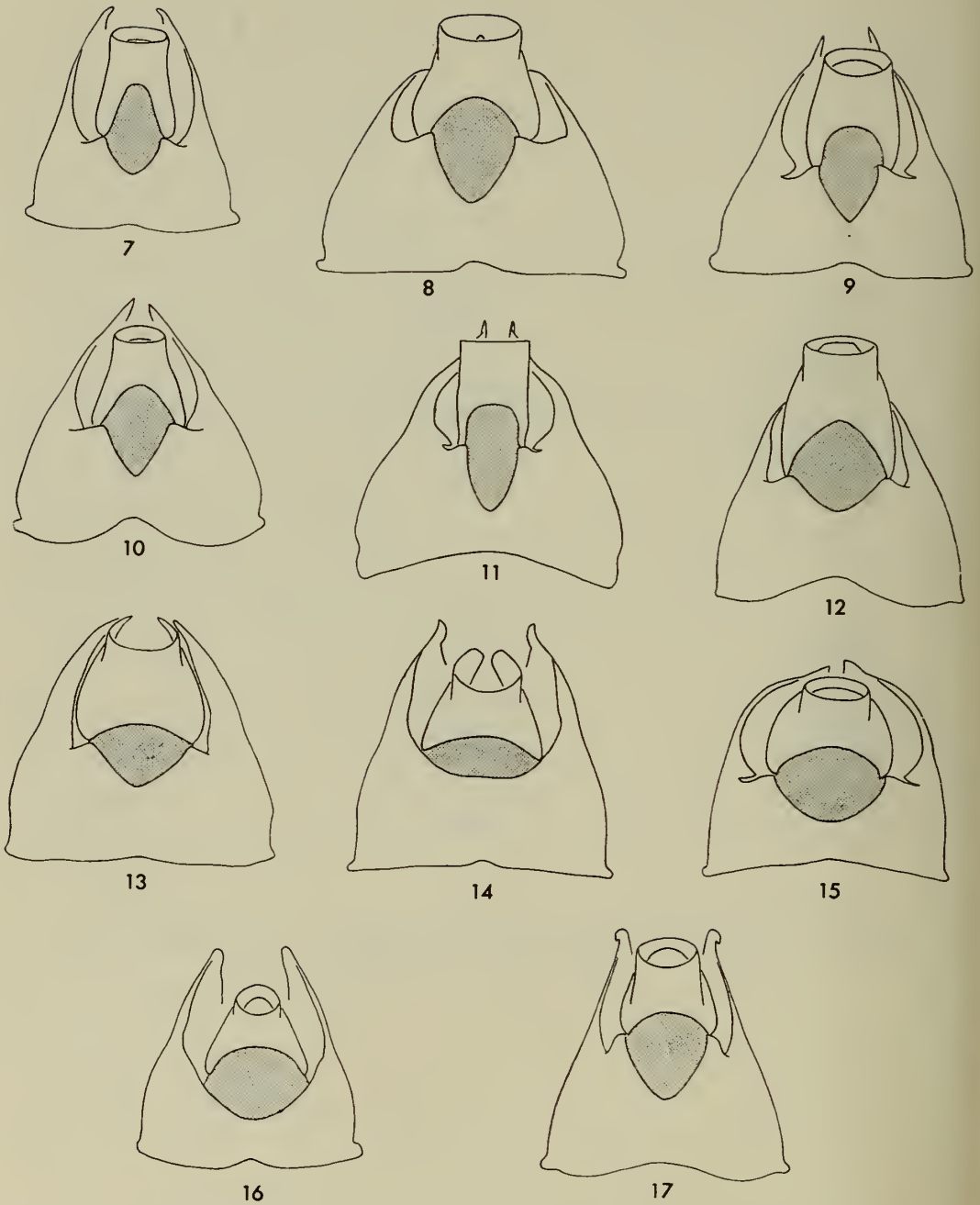
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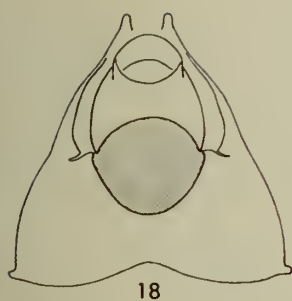




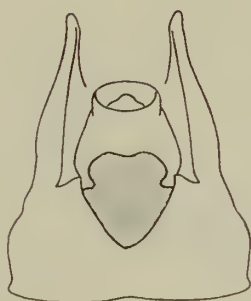
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FIGS 7-17. Dorsal view of male pygophore and Xth segment of *Diplocolenus* species. 7, *bohemani*; 8, *configuratus*; 9, *frauenfeldi*; 10, *altaicus*; 11, *nigrifrons*; 12, *alaicus*; 13, *logvinenkoae*; 14, *orientalis*; 15, *limbatellus*; 16, *convenarum*; 17, *quadrivirgatus*.



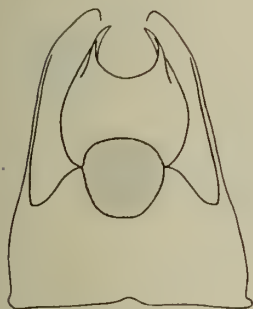
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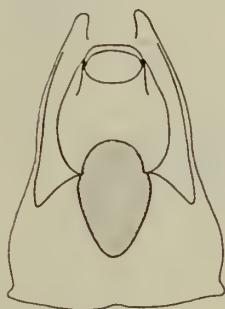
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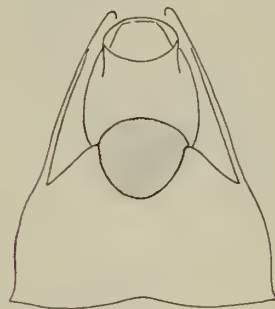
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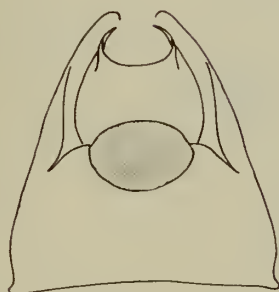
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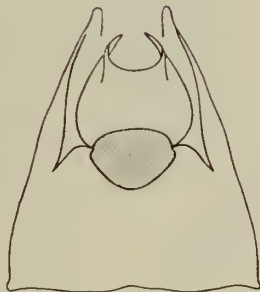
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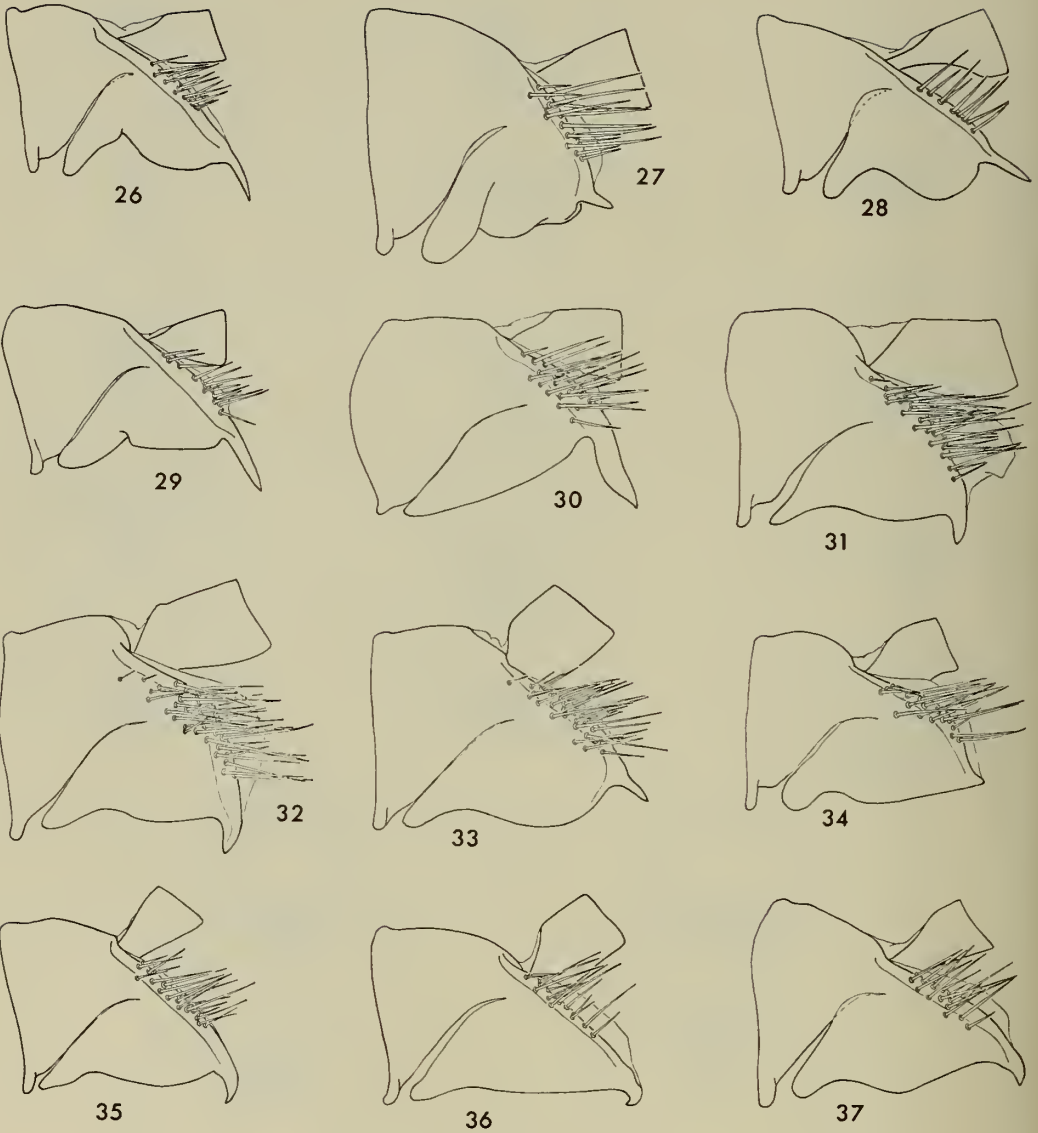


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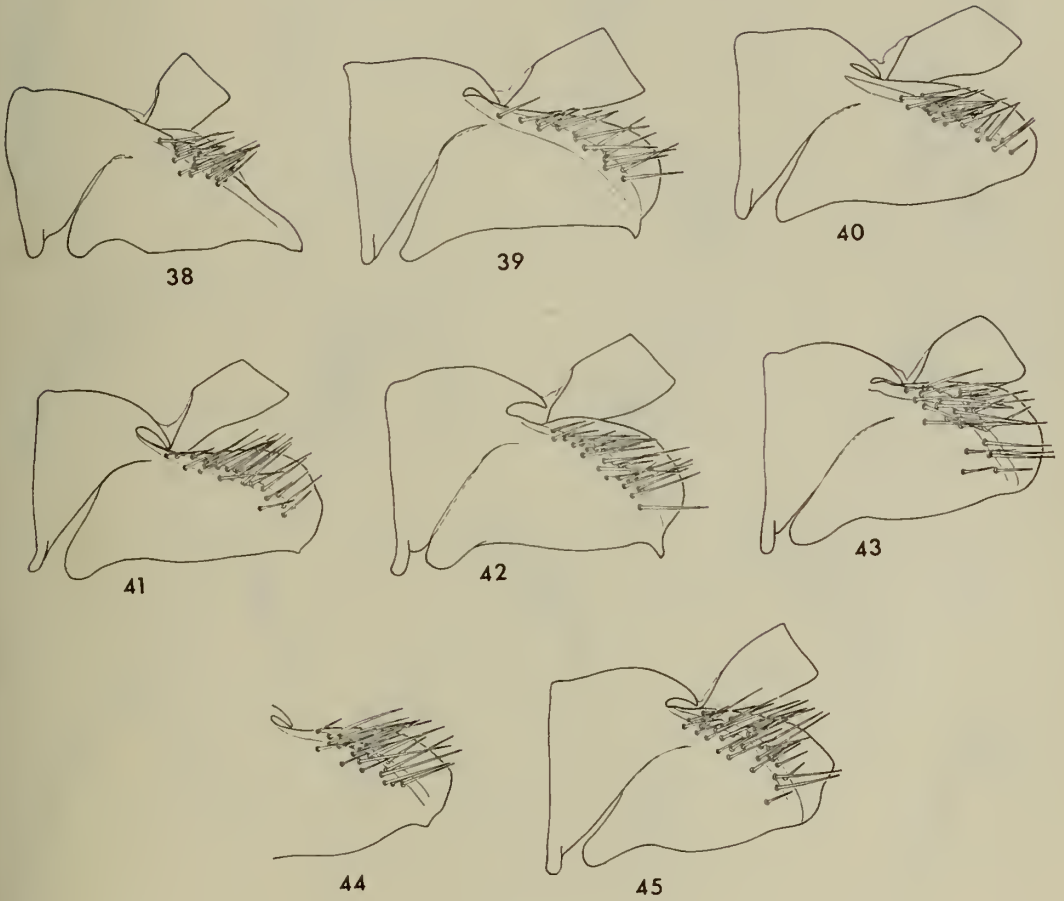


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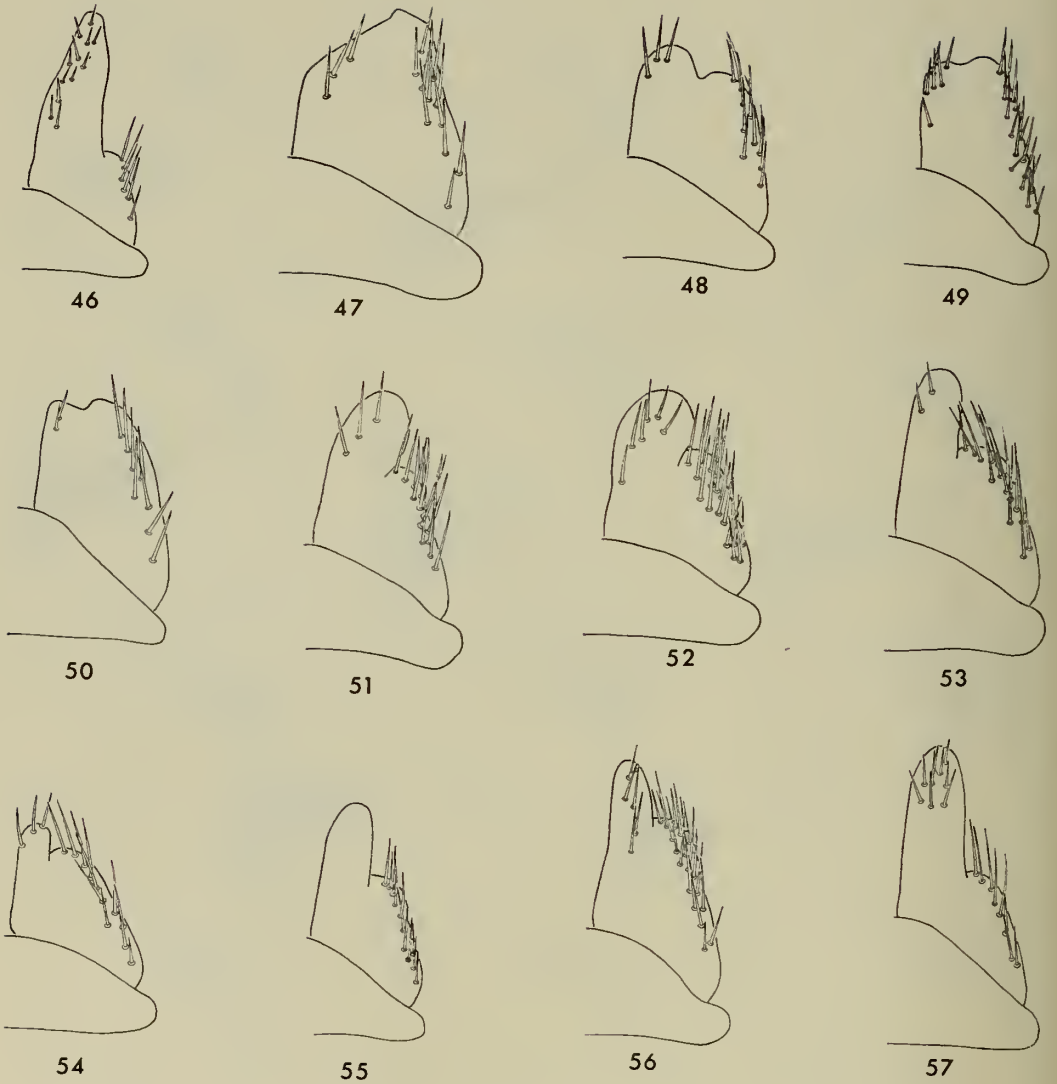
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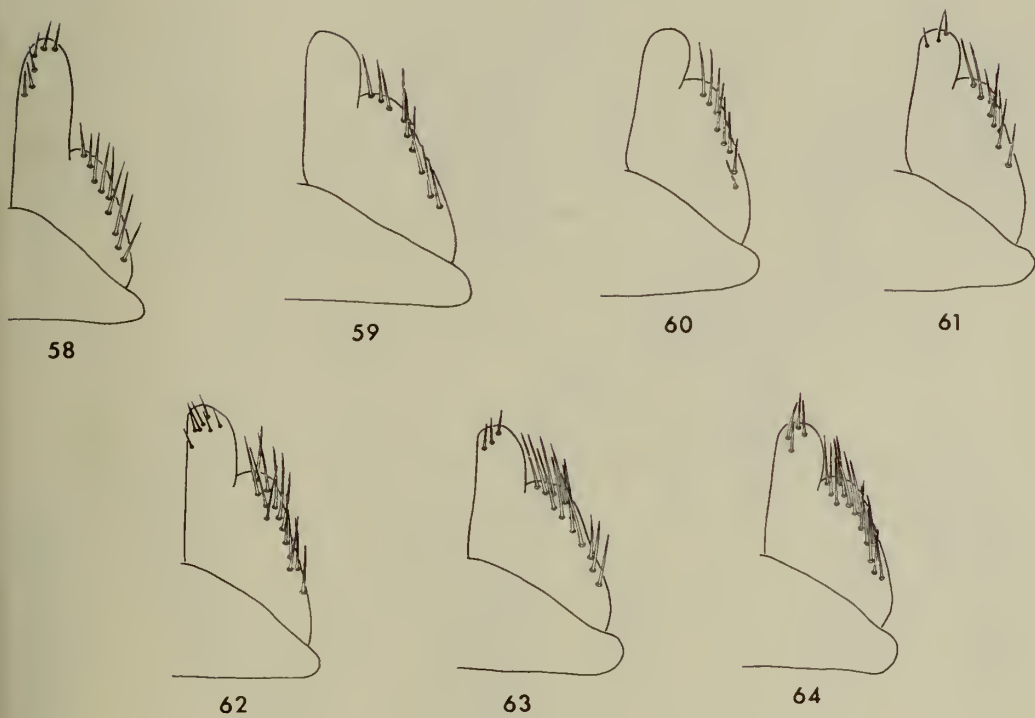
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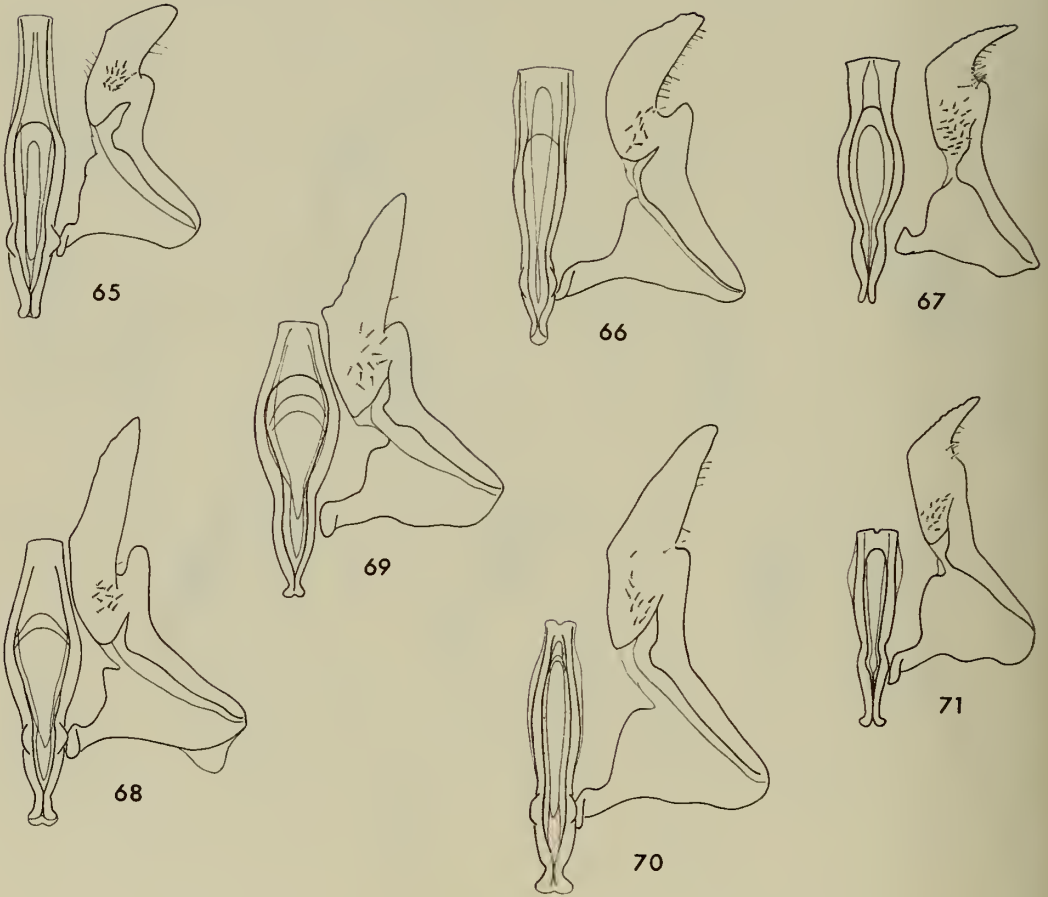
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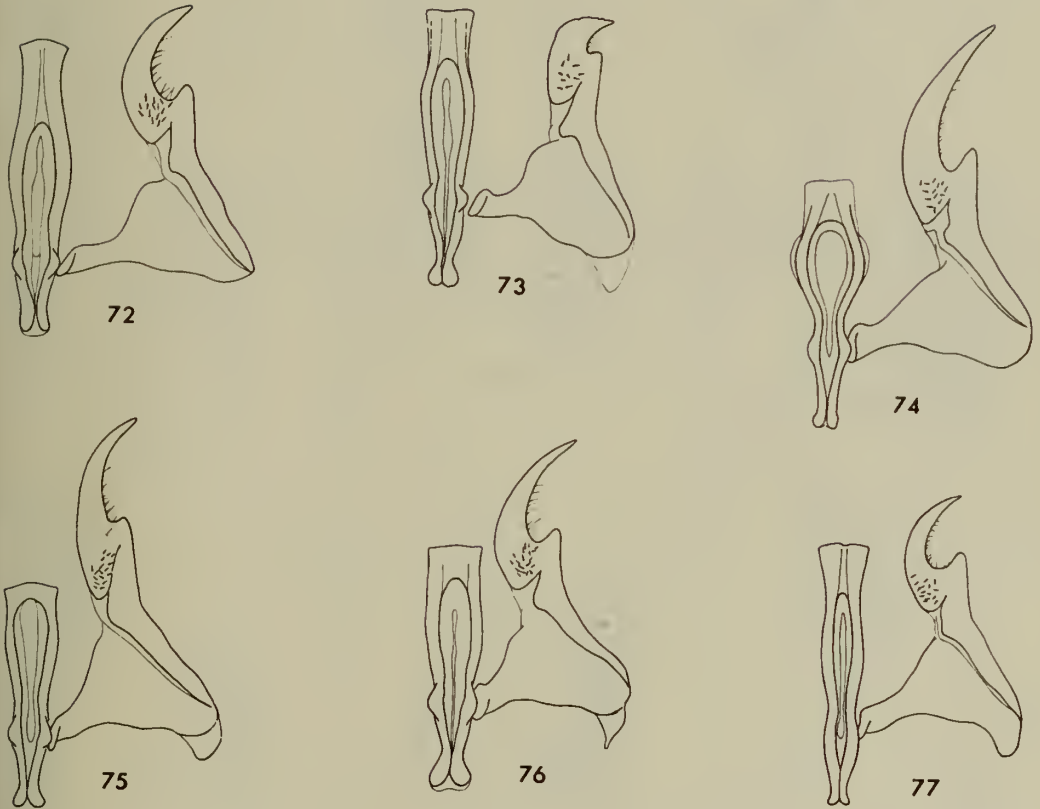


FIGS 58-64. Ventral view of right subgenital plate of *Diplocolenus* species. 58, *nigricans*; 59, *evansi*; 60, *abdominalis*; 61, *exsiliatus*; 62, *tianshanicus*; 63, *intermedius*; 64, *ciscaucasicus*.

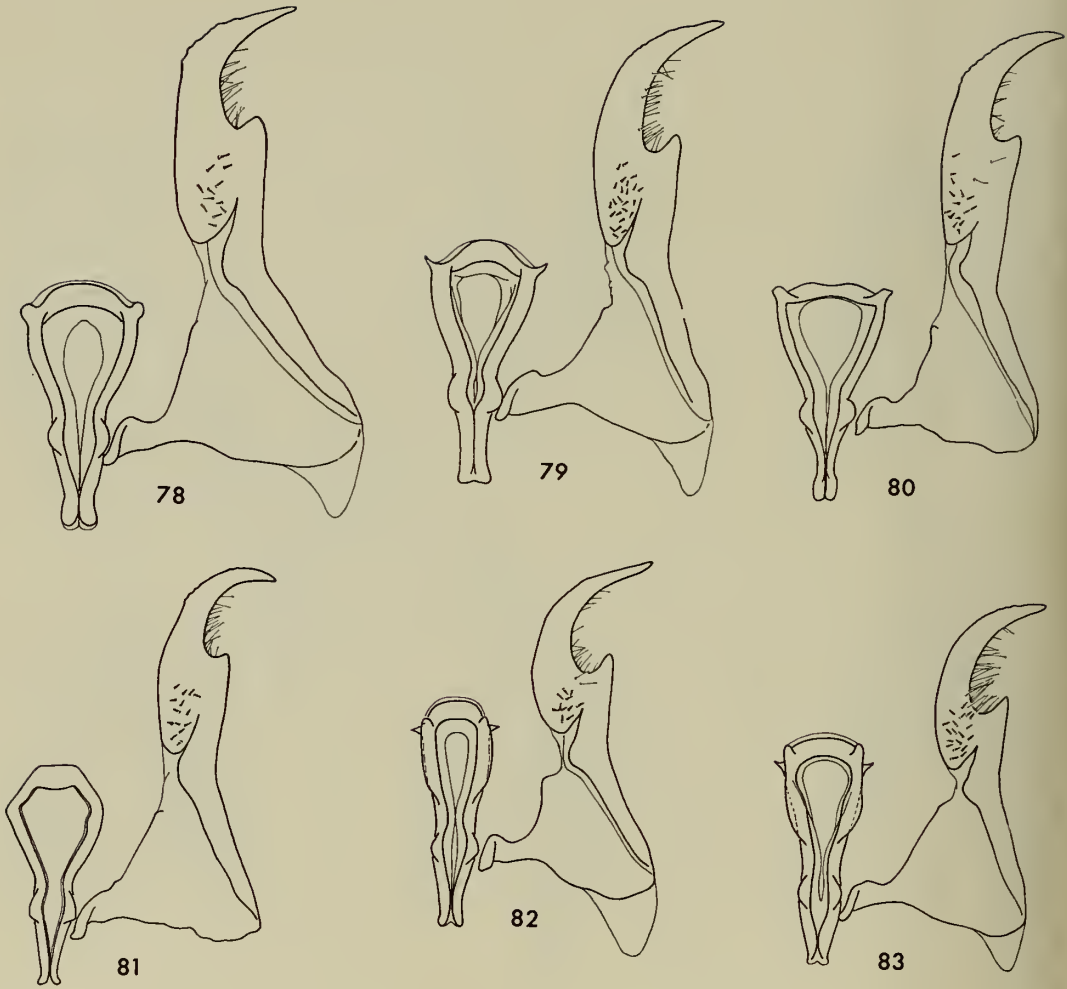


FIGS 65-71. Dorsol view of connective and left style of *Diplocolenus* species. 65, *bohemani*; 66, *nigrifrons*; 67, *logvinenkoae*; 68, *altaicus*; 69, *frauenfeldi*; 70, *configuratus*; 71, *alaicus*.

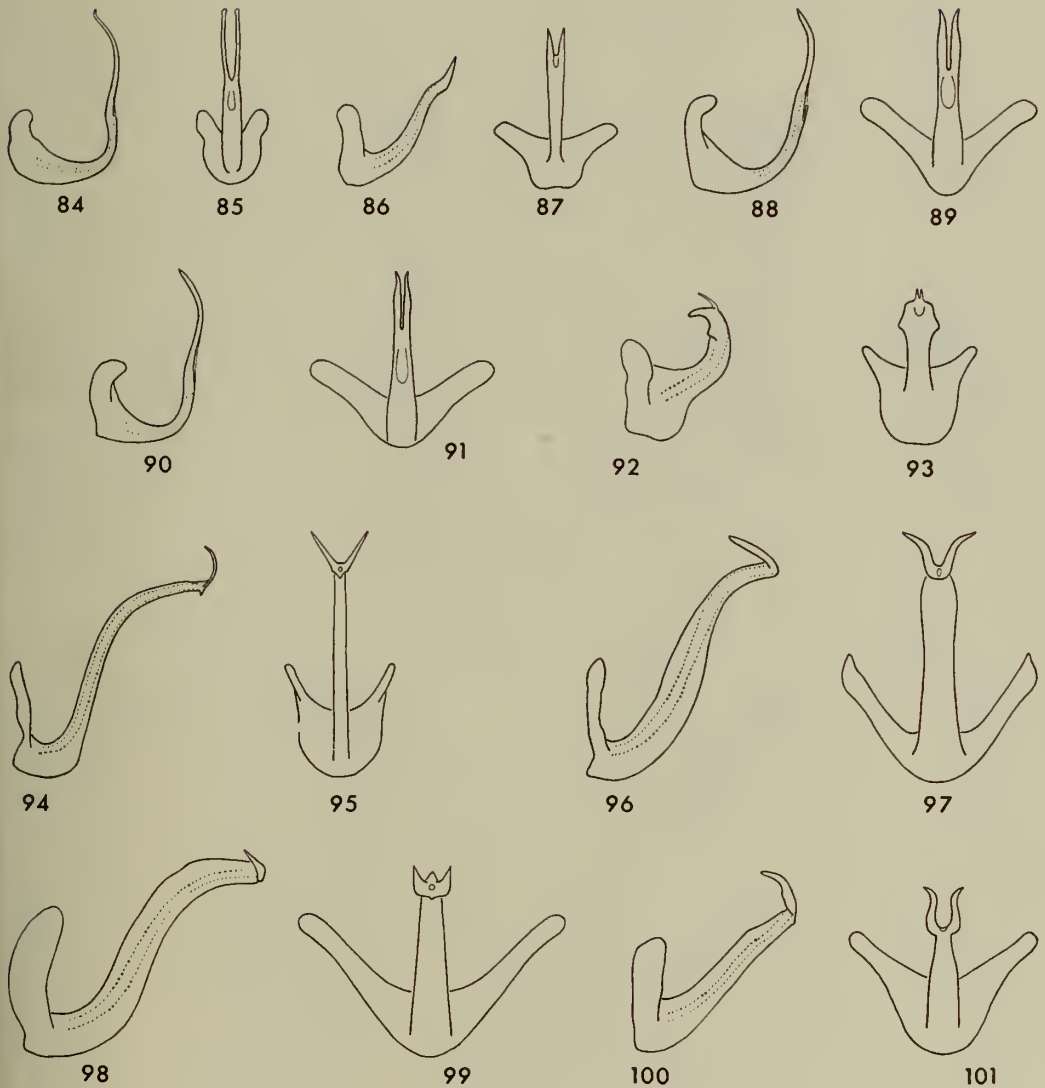




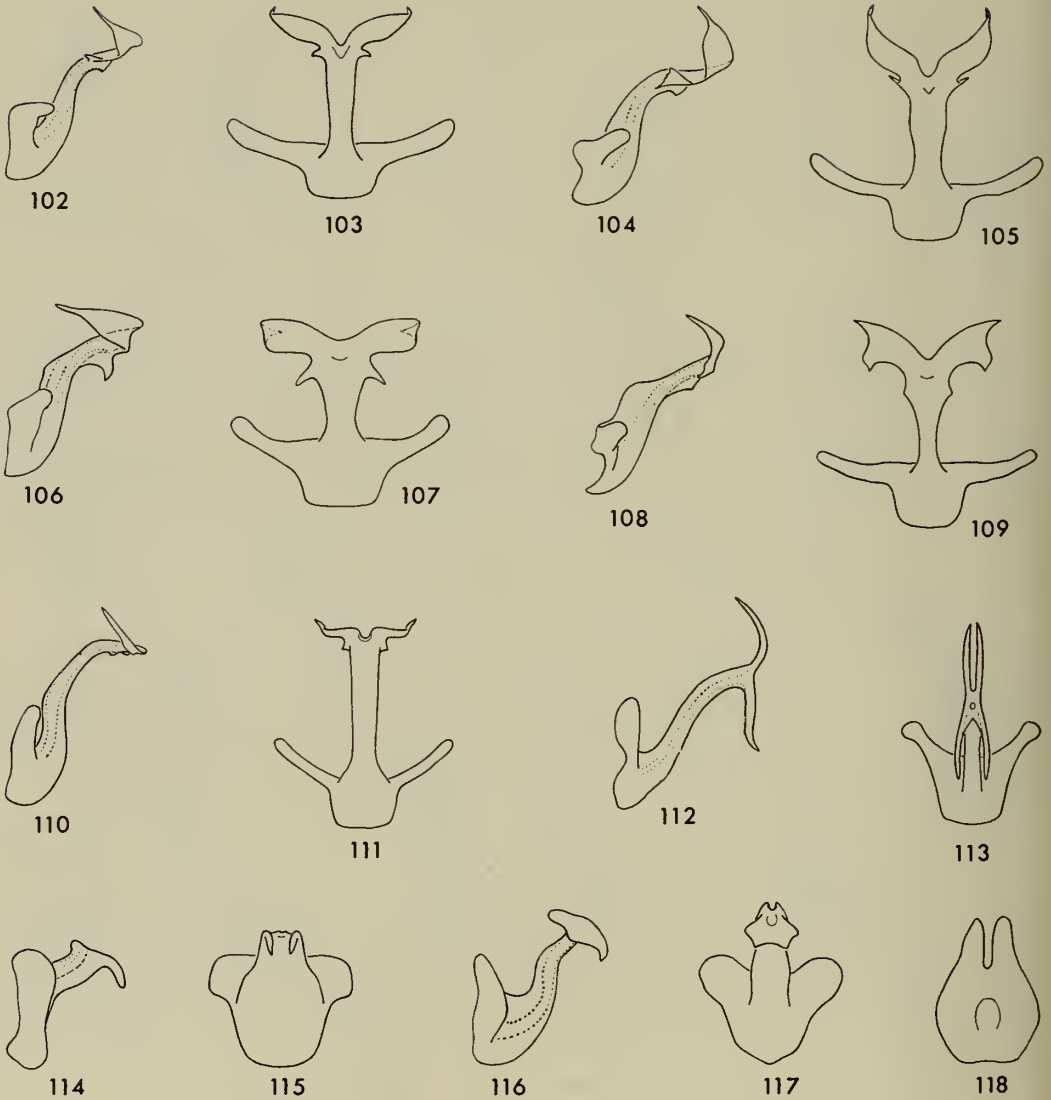
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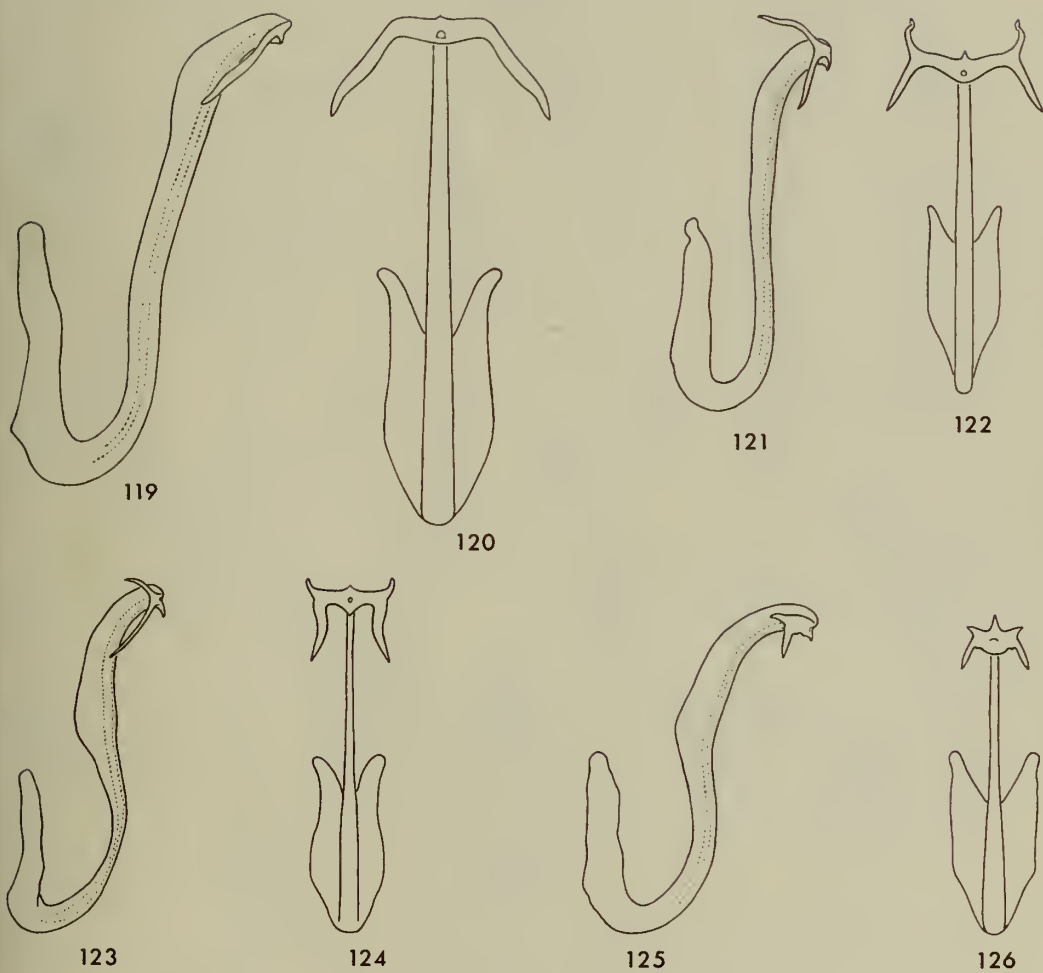
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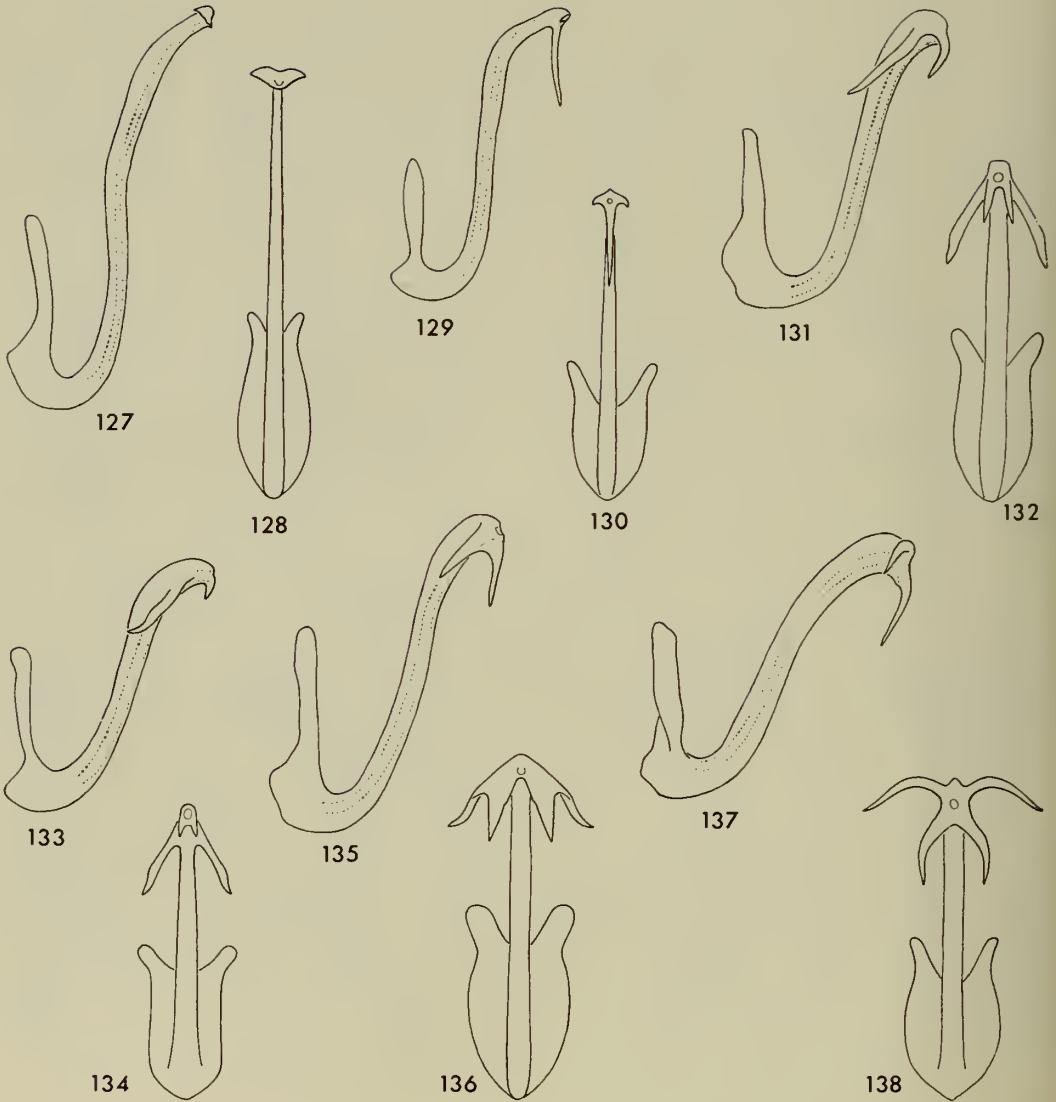
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FIGS 102-118. Left lateral and posterior views of aedeagus of *Diplocolenus* species. 102 & 103, *limbatellus*; 104 & 105, *kyrilli*; 106 & 107, *sichotanus*; 108 & 109, *kaszabi*; 110 & 111, *bensoni*; 112 & 113, *quadrivirgatus*; 114 & 115, *penthopitta*; 116 & 117, *nigricans*; 118, *nigricans*, dorsal view of apical plate of aedeagus.



FIGS 119–126. Left lateral and posterior views of aedeagus of *Diplocolenus* species.  
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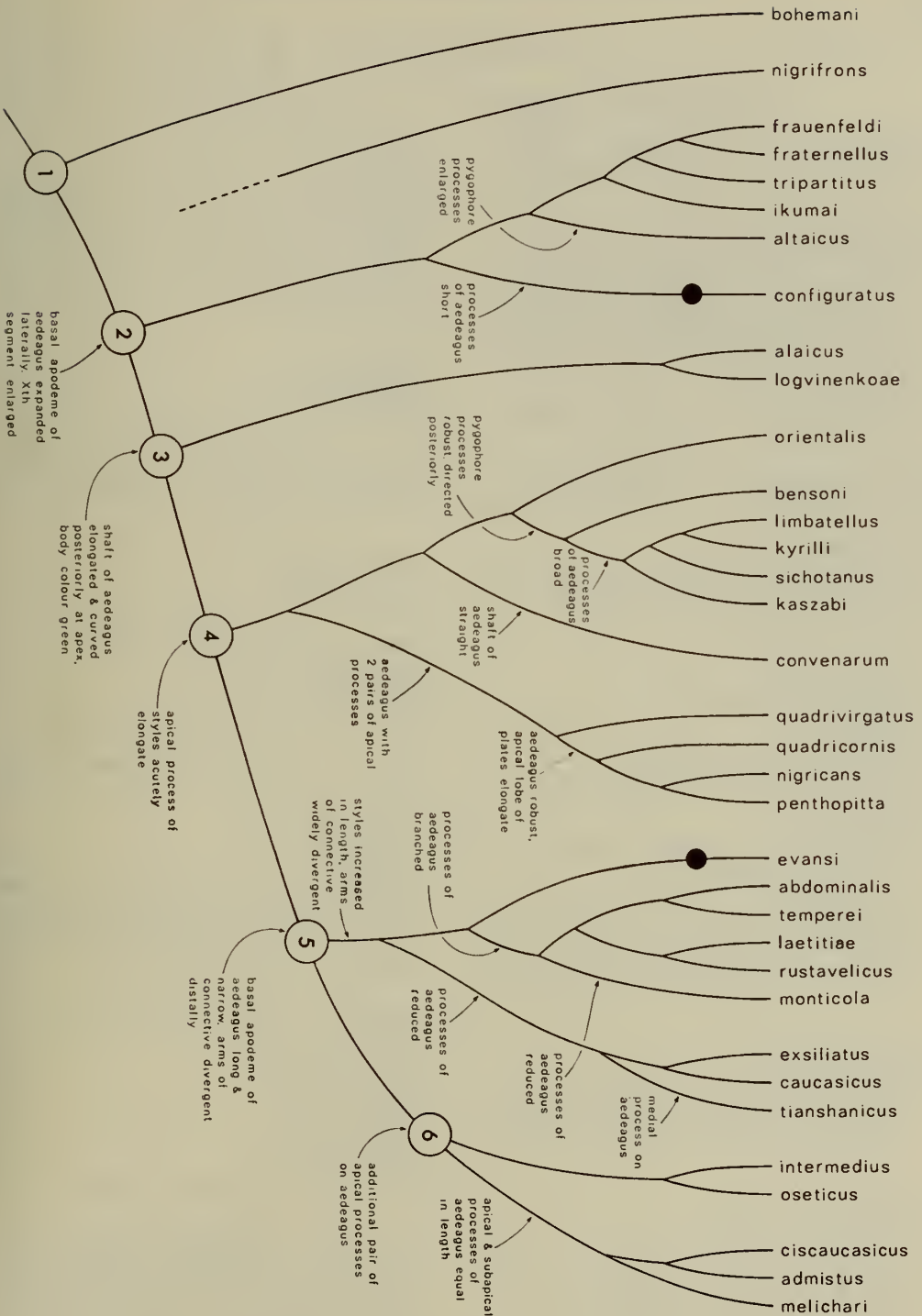


FIG. 139. Proposed phylogeny of *Diplocoenus*. Past dispersals from the Palearctic into the Nearctic Region are indicated by black circles. For further explanation see text (p. 363).

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